

# **KLINGE CORPORATION**

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**Manuals & Diagrams see – [www.klingecorp.com](http://www.klingecorp.com)**

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**MODEL NMG-115-06**

**GENERATOR SET**

**SERVICE AND PARTS MANUAL**

MANUFACTURED BY KLINGE CORPORATION

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Manual No. K35-05850-08-06



## TABLE OF CONTENTS

<b>SECTION ONE</b> .....	7
Specification	
<b>SECTION TWO</b> .....	9
Safety Precautions	
<b>SECTION THREE</b> .....	13
Engine Operation	
<b>SECTION FOUR</b> .....	21
Maintenance & Component Information	
<b>SECTION FIVE</b> .....	27
Service Parts	

## MARATHON LIMA MAC SERVICE MANUAL

## **Serial Numbers Registration – Warrantee**

The blue data plate machine serial number and the ISO container serial number should be reported to [engineering@klingscorp.com](mailto:engineering@klingscorp.com) at the time of installation. In the event that the installation date and which machine is on which container is not reported, the warrantee period will default to 18 months from the date of manufacture. Failure to report the above could result in the warrantee period being foreshortened.

## **Use of this Manual**

By extension, this manual may be used for other combinations of the same equipment but one would be better served by reference to the particular model, items, and variations. The model number on all Klinge Corporation equipment may be found on the blue serial number data plate. With the model number you may pull down and print out the whole or relevant sections of the manual from the [www.klingscorp.com](http://www.klingscorp.com) /manuals download/ then model number. If the particular model is not on the web page contact [engineering@klingscorp.com](mailto:engineering@klingscorp.com) or telephone (USA) (1) 717 840 4500.

The use of this manual is intended for the safe operation of the equipment described. It is therefore reasoned that persons who have the occasion to use this manual have a knowledge of mechanical and electrical systems and components addressed by its' contents. However, efforts have been made to enable persons less familiar with these systems to use this manual.

Suggestions as to improvement in content and format are welcome and should be addressed to [engineering@klingscorp.com](mailto:engineering@klingscorp.com) . Corrections and improvements will be included on dated revisions - the latest of which will be available on the web page.

## PRE-TRIP CHECKOUT FORM – **KLINGE** NMG-115 POWER GENERATORS

DATE:

UNIT NO.:

LOCATION:

HOURLY METER READING:

DATE OF LAST PRE-TRIP:

Each item should be checked in the “pre-trip done” column, and numerical values should be recorded in the spaces provided. Any damaged, defective, or missing part must be replaced or repaired and re-tested.

Pre-Trip Done

1. Inspect generator set for damage, missing parts, and loose mounting bolts.

2. Check fuel level. Use ASTM D975-96 #2-D or #1-D in cold weather; DIN EN 590; BS 2869; NATO Code F-54/F-34/F-44 and XF 63 or equivalents.

3. Inspect fuel sediment bowl and strainer for water or contaminants. Drain water from bowl, clean bowls and strainer if necessary.

4. Check engine oil level with dipstick. Add oil to dipstick mark as needed. Use SAE 15W-40 API service CF/CH-4 oil; ACEA E2-96 E3-96 E5-02 or equivalents.

5. Check that NO MORE THAN 1000 HOURS or ONE YEAR since fuel and oil filters have been changed. Replace filters and change oil if required. Write date and hour meter reading on new filters using indelible marker.

6. Check air filter and air intake hoses and make sure that; the green flag on the restriction gauge is visible; the rubber Vacuator valve on the dust cup is in good shape and faces down; all rubber hoses are OK; clamps are tight

7. Make sure that fan is not damaged and that cooling are circulation is not obstructed.

8. Check fan belt for wear, cracks, and proper tension. Tighten or replace as needed.

9. Check for frayed battery cables, cracked wire insulation, and for clean and secure electrical connections. Clean or replace as needed. Clean or replace as needed.

10. Connect power cable of a refrigeration unit to the diesel generator set. Make sure the both the Power Switch on the generator set and the ON/OFF switch on the refrigeration unit are on “OFF.”

11. Start generator set. Wait until engine speed stabilizes and oil pressure reaches a minimum of 30 psi.

12. Turn "ON" the generator Power Switch and afterwards the ON/OFF switch on the refrigeration unit.

13. Check engine oil hose and fuel lines. Tighten or replace any component where leaks appear. Observe exhaust system. If exhaust is dirty, stop engine and clean air filter cartridge. Clean by blowing compressed air at 2-3 psi only from the inside of cartridge.

14. Observe VOLTMETER to insure battery is charged. Reading should be 14V.

15. Observe and record HOURMETER reading at top of form.

16. Turn Power Switches on generator set and refrigeration unit to "OFF"

Record service information on record chart on unit and secure all doors.

REMARKS



## **SECTION ONE**

### **SPECIFICATIONS**

#### **General**

The NMG-115-06 (Nose Mount Generator Set) was specifically designed to meet the rigorous demands of ocean, over-the-road, and rail transport of 20' and 40' refrigerated containers. The NMG-115-06 can be mounted quickly in the nose of a container, using only four bolts.

#### **Construction**

Welded aluminum frame  
Aluminum doors and closures  
Stainless steel hardware

#### **Engine**

Deutz F3M2011 Oil Cooled Diesel  
Three Cylinder, 2.33 L, direct injected, 32.8 BHP (24.5 kW), @ 1800 rpm  
1000 hour maintenance intervals

#### **Generator**

15 kW Marathon Lima MAC Reefer, specifically designed for starting 3 phase AC electrical motors. Single bearing, 1800 RPM, 240 / 480 Y Volts, 0.8 Power Factor, Class F / H Insulation , 104°F / 40°C Ambient, 10 Leads, Self-excited and Inherently Regulated providing 4% voltage regulation without external voltage regulator or transformer, with automatic Volts / Hertz operation capability. The air intake is labyrinth baffled to minimize particle and moisture penetration

#### **Temperature Operating Range**

-40° F to 104° F (-40° C to 40° C)

#### **Weight**

1315 lbs (596 kg) without fuel  
1665 lbs (755 kg) with full fuel tank

#### **Mounting**

Mounting clip in back, 4 bolts in front

#### **Fuel Capacity**

50 gallons (190 L) usable (approx. 56 hours of operation under full load)

#### **Voltage**

480 V AC / 3 phase / 60 Hz (Standard)  
25 A Power circuit breaker  
CEE 17, 32 A Power receptacle  
Optional  
230 VAC / 3 phase / 60 Hz  
50A Power Circuit breaker

50 or 60 a power receptacle

### **Controls**

Single engine “MAN / OFF/ AUTO” toggle switch

Low oil pressure switch

High oil temperature switch

Electronic control and fault protection unit (ECU)  
with lamp indicators for cause of shut down.

Engine oil pressure gauge

Engine hour meter

Voltmeter for battery charging control

### **Battery Starting System**

55 A, 14 V DC battery charging alternator

One 925 CCA, 175 RC, 12 V DC battery

2.2 kW, 12V starter motor

### **Fuel System**

Fuel strainer

Dual fuel filters with water separator

In-line fuel heater

Cam-actuated mechanical lift pump fuel lift pump

### **Lubrication System**

1000 hour oil change interval

9 qt (8.5 liter) capacity oil pan (oil sump)

3 qt (2.8 liter) capacity external oil cooler

### **Combustion Air Cleaning System**

One high performance two stage Cyclopac air filter with Extended Life dry cartridge and automatic dust and water expelling Vacuator valve. Air cleaner restriction indicator for maximum filter life



## SECTION TWO

### SAFETY PRECAUTIONS

#### ROTATING HAZARDS

1. Keep your hands, clothing, and tools clear of the alternator belt when the generator set is running.
2. If it is necessary to run the generator with the end cover removed, be very careful with tools or meters being used in that area to avoid contacting the rotor.

#### BATTERY HAZARDS

Few people realize just how dangerous a battery can be.

The electrolyte in a lead acid battery is dilute sulfuric acid ( $H_2SO_4$ ). During charge or discharge functions of a battery, a chemical change takes place within the individual cells that cause the bubbling we see through the filler hole. This gas bubbling is hydrogen and oxygen, and it is **EXPLOSIVE**. If during this gassing action, a means of ignition is present, an explosion could occur. A defective battery may suddenly explode even while standing idle. Added to this danger, consider a fall-out of highly corrosive sulfuric acid caused by the explosion. A rubber blanket or other cover can be used to reduce the risk from possible explosion.

#### PRECAUTIONS

1. Always wear eye protection when servicing batteries. If electrolyte is splashed on the skin or in the eyes, flush immediately under running water. Obtain medical help as soon as possible.
2. When charging batteries, do not remove the vent caps.
3. When disconnecting or reconnecting the generator-set battery make sure the ON/OFF switch is in the **OFF** position to prevent an arc, which could cause the battery to explode. Disconnect the ground cable first, preferably at a point away from the battery. Reconnect the ground cable last, again away from the battery if possible.
4. **DO NOT** check a battery by "**sparking**" across the posts. Eye injury from the arc or explosion may occur.

## **ELECTRICAL HAZARDS**

### **HIGH VOLTAGE**

When servicing or repairing a generator set, the possibility of serious or even fatal injury from electrical shock exists. Extreme care must be used when working with an operating generator. Lethal voltage potentials can exist on connections that are in the exciter control box.

### **PRECAUTIONS**

1. When working on high voltage circuits on the generator sets, **DO NOT** make any rapid moves. If a tool drops, **DO NOT** grab for it. People do not contact high voltage wires on purpose. It occurs from an unplanned movement.
2. Make sure of your footing. If you slip, you will instinctively grab for support. This can be lethal around a generator set. Work on rubber mats or dry wood if possible.
3. Use tools with insulated handles that are in good condition. Never hold metal tools in your hand if exposed energized conductors are within reach.
4. Treat all wires and connections as high voltage until a meter and wiring diagram show otherwise.

**IMMEDIATE** action **MUST BE** initiated after a person has received an electrical shock.

Obtain expert medical assistance if available.

The source of shock must be immediately removed by either shutting down the generator power or removing the victim from the source. If it is not possible to shut off the generator set, the wire should be cut with an insulated tool (e.g. a wooden handled axe or cable cutters with heavy insulated handles), or a rescuer wearing insulated gloves. Whichever method is used, **DO NOT** look at the wire while it is being cut. The ensuing flash can cause blindness. Remember that insulated gloves **MUST BE** insulated and not just rubber gloves manufactured for protection from liquids. If the victim has to be removed from live circuitry, pull him off with a non-conductible material. Use his coat, a rope, wood or loop your belt around his leg or arm and pull him off. **DO NOT TOUCH** him, you could receive a shock from current flowing through his body. After separating the victim from the power source, check immediately for respiration and presence of pulse. If a pulse is present, respiration might be restored by mouth-to-mouth resuscitation.

## LOW VOLTAGE

Control circuits utilized by the generator set are low voltage (12 volts D.C.). This voltage potential is not considered dangerous, but the large amount of current available (over 300 amps) can cause severe burns if shorted to ground.

1. Disconnect the negative terminal of the battery if possible when working on the generator set. Disconnect the cable end that is away from the battery.
2. **DO NOT** wear jewelry, watches, or rings. These items can short out and cause severe burns to the wearer.

## GENERAL SAFETY PRECAUTIONS

1. Use extreme caution if holes are drilled into the generator set. Holes drilled into an electrical wire can cause fire, explosion, or shock hazard.
2. Be sure all mounting screws are tight and are the correct length.
3. Keep tools and equipment clean and in good working condition. Accidents occur when you attempt procedures without the proper tools.

## **SAFETY DO'S AND DON'TS**

### **DON'T**

**DON'T** allow inexperienced personnel to work on the generator or electrical equipment.

**DON'T** remove guards or protective devices.

**DON'T** wear loose clothing or jewelry in the vicinity of moving parts. These can get in machinery, with disastrous results.

**DON'T** wear jewelry while working on electrical equipment. If your hair is long, wear a head covering. Hair caught in a drill press, fan belt or other moving part can cause serious injury.

**DON'T** stand on a wet floor while working on electrical equipment. Use rubber insulated mats placed on dry wood platforms.

**DON'T** lunge after a dropped tool. To do so may place you in a position of extreme danger.

**DON'T** commence any operation until you have taken all the necessary steps to ensure that you are in complete safety.

### **DO**

**DO** perform your tasks carefully, without undue haste.

**DO** provide fire extinguishers (rated ABC).

**DO** provide a First Aid Kit (for burns and abrasions). Obtain medical attention, if necessary.

**DO** use the correct tools for the job you are doing.

**DO** make sure that all fasteners are secure.

**DO** use extreme care while making adjustments on the generator set while it is running.

**DO** keep your hands away from moving parts.

**DO** remember - Horseplay is for horses! It has no place around machinery.

**DO** disconnect batteries before starting work on the generator set.

**DO** use screwdrivers, pliers, diagonal pliers, etc. with insulated handles.

**DO** remember to keep one hand in your pocket if it is necessary to work on "live" circuits. To do so will prevent passage of electricity into one hand and out the other, which passes current across the heart.

**DO PRACTICE SAFETY. THE LIFE YOU SAVE MIGHT BE YOUR OWN**

## **SECTION THREE**

### **ENGINE OPERATIONS**

#### **3.1 PRE-START INSPECTION**

1. Check fuel level - Use diesel fuel ASMD 975-96 No. 1-D or No. 2-D or equal.
2. Check engine oil level - Use SAE 15W 40 or 10W 40 Oil, for normal operation.

#### **3.2 OPERATING INSTRUCTIONS**

The starting and stopping of the generator set, controlled by the ECU (engine control unit), is operated from a single Toggle Switch located on the control box. There are two modes to start and operate the unit, "MANUAL" and "AUTOMATIC"

##### **3.2.1 MANUAL**

Place the "MAN - OFF - AUTO" toggle switch in the "MAN" position. The Engine Fuel Solenoid and the Starter Relay will be energized by the ECU causing the engine to begin cranking. If the engine does not start in the allotted time as determined by the Crank Cycle Adjust, the Overcrank Fault occurs and the Starter Relay and the Engine Fuel Solenoid are turned off. At the same time the "OVERCRANK" LED on the ECU will turn on. In order to initiate a new start cycle and clear the fault condition, the toggle switch must be placed momentarily in the "OFF" position and then again in the "MAN" position. To stop the engine or to clear a fault condition, place the toggle switch in "OFF" position.

##### **3.2.2 AUTOMATIC**

Place the "MAN - OFF - AUTO" toggle switch in the "AUTO" position. After a short delay set by TIMER 1 located in the control box, the Crank Cycle will be initiated. The factory setting for the delay is 0.1 to 0.2 minutes. If the engine does not start at the first attempt, the crank mode will continue for the duration of the settings of the Crank Cycle Adjust and the Dip Switch. The factory setting for the ECU is for eight cycles. If the engine fails to start after eight cycles, Overcrank Fault will occur, and the Fuel Solenoid and Starter Relay will be turned off. At the same time the "OVERCRANK" LED on the ECU will turn on. To stop the engine or to clear a fault condition, place the toggle switch in "OFF" position.

**NOTE:** If the signal from the magnetic sensor located in the flywheel housing of the engine is lost during cranking or running, the engine will shut down and the Overcrank and Overspeed LED's on the ECU will both turn on. This is valid for both ways of operation, Manual or Automatic

#### **3.3 OPERATIONAL CHECK**

- 1 - Voltmeter should indicate 14V-alternator output voltage.
- 2 - Hour meter indicator should be rotating.

3 - Oil pressure gauge should indicate oil pressure.

### **3.4 ENGINE PROTECTION CONTROLS**

There are several safety devices employed to prevent damage to the engine, or the electrical system, should a potentially dangerous situation occur.

The DC circuit breaker CB-2 protects DC components and wiring from a short circuit situation. The breaker will reset periodically until the short circuit is removed.

**REPLACEMENT DC CIRCUIT BREAKERS MUST BE INSTALLED PROPERLY WITH THE BATTERY TERMINAL CONNECTED TO THE LINE OR BATTERY SIDE OF THE CIRCUIT AND THE AUXILIARY TERMINAL CONNECTED TO THE LOAD SIDE OF THE CIRCUIT.**

Three safety shutdown devices are used to protect the engine. One is the oil temperature switch (OTS) that actuates at 266°F (130°C). Another is an oil pressure switch (OPS) that actuates at 25 psi(1.72). The third is the alternator output (W). Each of these devices is wired to engine control unit (ECU). If a failure occurs the appropriate LED will light indicating the failure.

### **3.5 ENGINE CONTROL UNIT (ECU)**

The Engine Control Unit is a microprocessor controlled device which provides complete automation and safety monitoring of the engine. The ECU is epoxy encapsulated into a mounting case and it is able to withstand a wide ambient temperature range from -40°F (-40°C) to +185°F (+85°C) as the shock and weather conditions encountered in transport applications. The ECU automatically cranks, starts and monitors the engine for Overcrank, Overspeed, High Coolant Temperature and Low Oil Pressure. Any crank timing sequence is accomplished by using the single (MAN) or multiple (AUTO) crank modes in conjunction with the timer adjustments. A built in speed switch uses a magnetic speed sensor located in the engine flywheel housing to monitor engine speed for crank disconnect and overspeed. With disconnect RPM set between 350 and 500 rpm, cranking will terminate after 20 seconds if engine fails to start.

A bypass timer/logic assures Low Oil Pressure and High Coolant Temperature override during the crank period and an additional adjustable period after crank disconnect. The factory setting for this delay is 20 seconds.

**For additional information related to the Engine Control Unit see the attached Data Sheet at the end of the manual.**

### **3.6 ENGINE ELECTRICAL CONTROL OPERATION**

When the toggle switch is placed in "MAN" or "AUTO" position voltage will be supplied to the Engine Control Unit and relays (R2) and (R3) will be energized. Relay (R2) will provide power to the Fuel Solenoid, Fuel Heater, Oil Pressure Gauge, Hour Meter, Volt Meter 12 DC and to relay (R7) - Battery Charger Cutout. Relay (R3) will start the engine or stop cranking if engine fails to start in 20 seconds. Relay (R3) will also energize relay (GPR) which will activate the glow plug during the cranking cycle if the engine temperature is below +55°F (+12.7°C). The

engine temperature is checked by the Engine Temperature Switch (ETS) installed on the flywheel housing. Low oil pressure or high oil temperature will stop the engine by de-energizing relay (R2). A red LED will indicate the type of failure.

### **3.7 ENGINE RPM AND FREQUENCY**

The engine must be set to run at 1800 to 1850 rpm corresponding to a frequency of 60 to 62 Hz at FULL LOAD. Full load is considered to be when the reefer unit runs in an ambient of + 90 to 100°F (+ 32 to 38° C) and the box temperature is + 32°F ( 0°C) or above

### **3.8 FUEL QUALITY GRADE**

Always use branded grades of diesel fuel having a sulphur content of less than 0.5%. In the case of a higher sulphur content, the periods between oil changes must be shortened.

The following fuel specifications are approved:

- \*DIN EN 590

- \*NATO Codes F54, F34/F44 and FX63

- \*BS 2869: A1 and A2  
(In case of A2, note sulphur content)

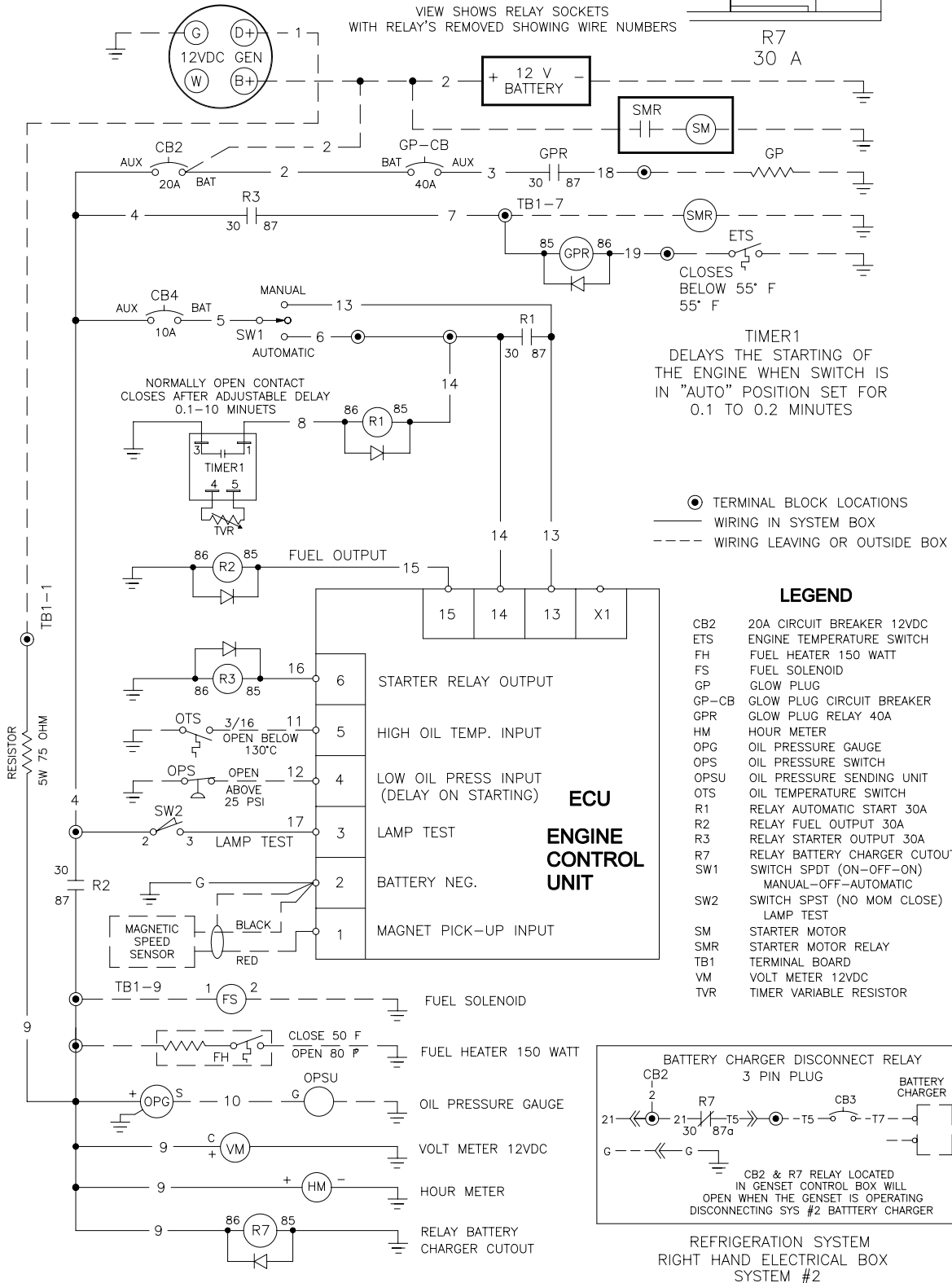
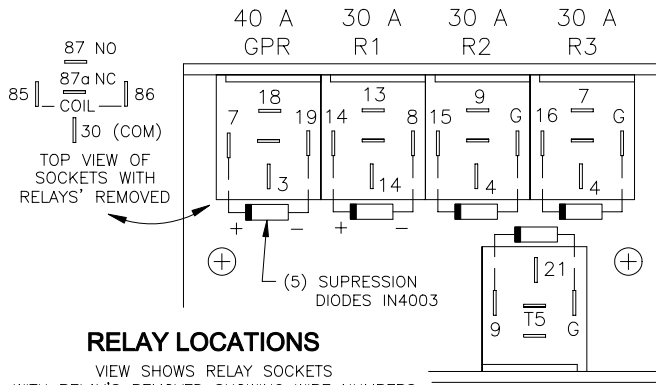
- \*ASTM D 975-96: 1-D and 2-D

- \*VV-F-800a: DF-A, DF-1, and DF-2

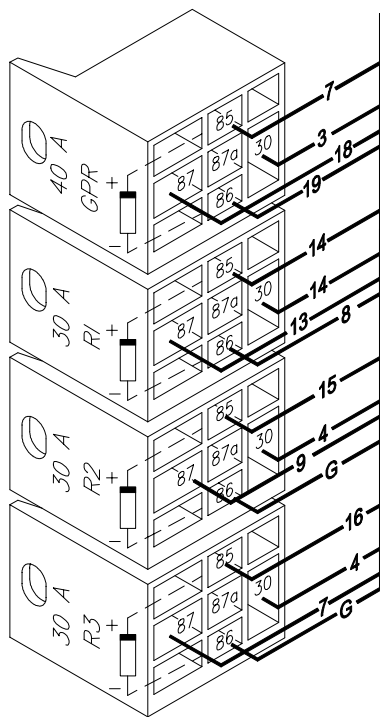
### **3.9 ELECTRICAL SCHEMATIC AND WIRING**

**NOTE: UNDER NO CONDITIONS SHOULD THE RPM BE BELOW 1800 OR THE FREQUENCY BELOW 60 HERTZ**

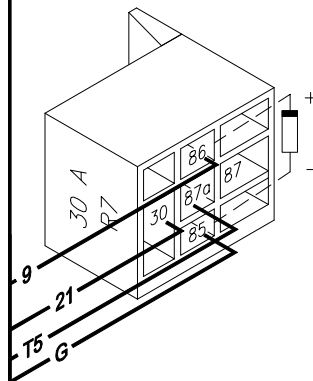
**ELECTRICAL SCHEMATIC  
MODEL NMG-115-04/05/06  
ENGINE GENERATOR**



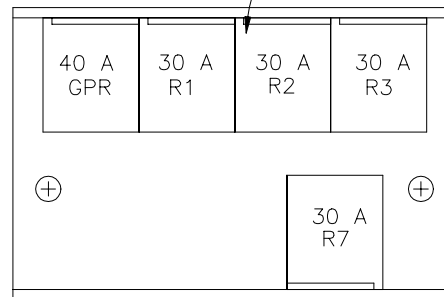




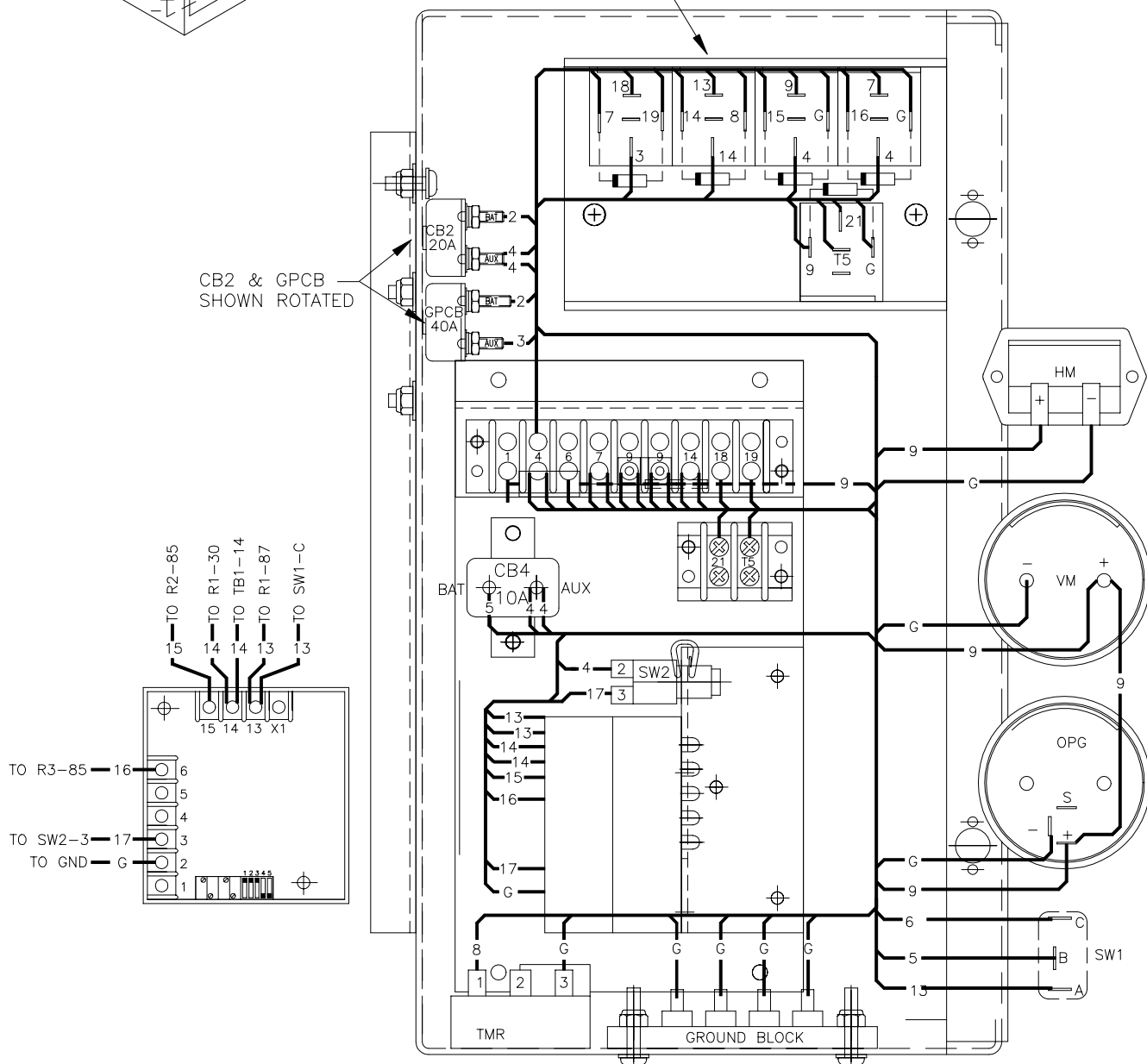
BOTTOM VIEW OF  
RELAY BASES  
FOR REFERENCE ONLY



87 NO  
85 87a NC  
COIL 86  
30 (COM)  
RELAY  
CONTACT  
NUMBERS

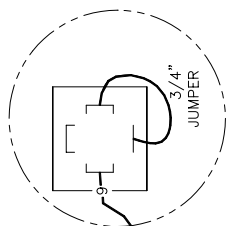


WIRES ARE CONNECTED TO BACK OF BASE  
SHOWN LOOKING AT TOP OF RELAY BASE

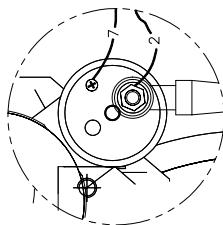


## WIRING INSIDE CONTROL BOX

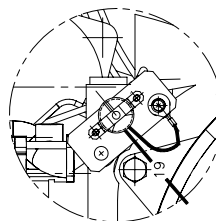
# WIRING ENGINE HARNESS TO ENGINE



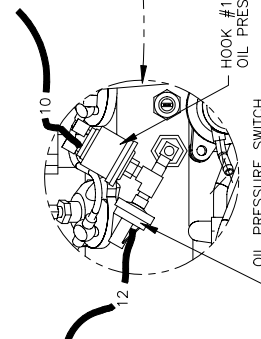
FUEL SOLENOID  
INSIDE VIEW



SECTION E-E  
STARTER

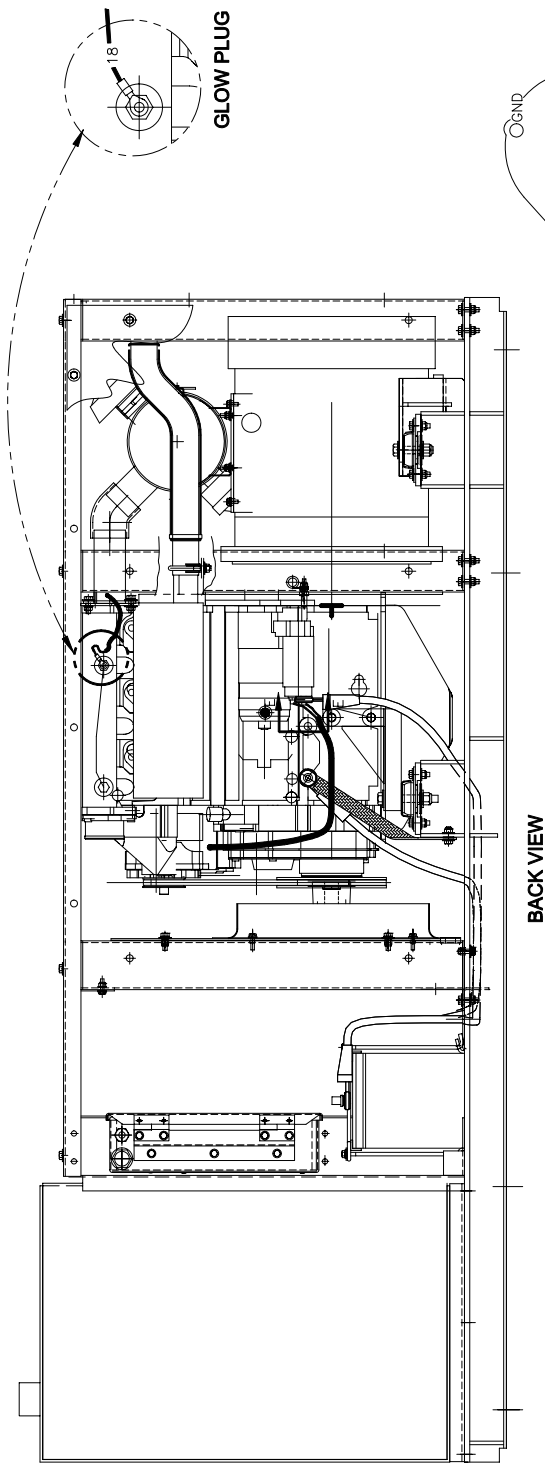


SECTION D-D  
ENGINE TEMPERATURE SWITCH

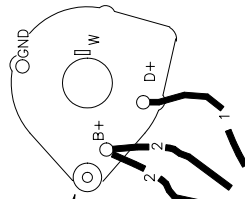


HOOK #10 TO G NOT WK  
OIL PRESSURE SENDING UNIT

OIL PRESSURE SWITCH



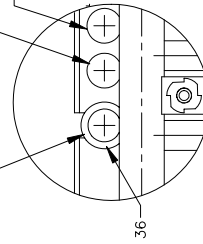
BACK VIEW



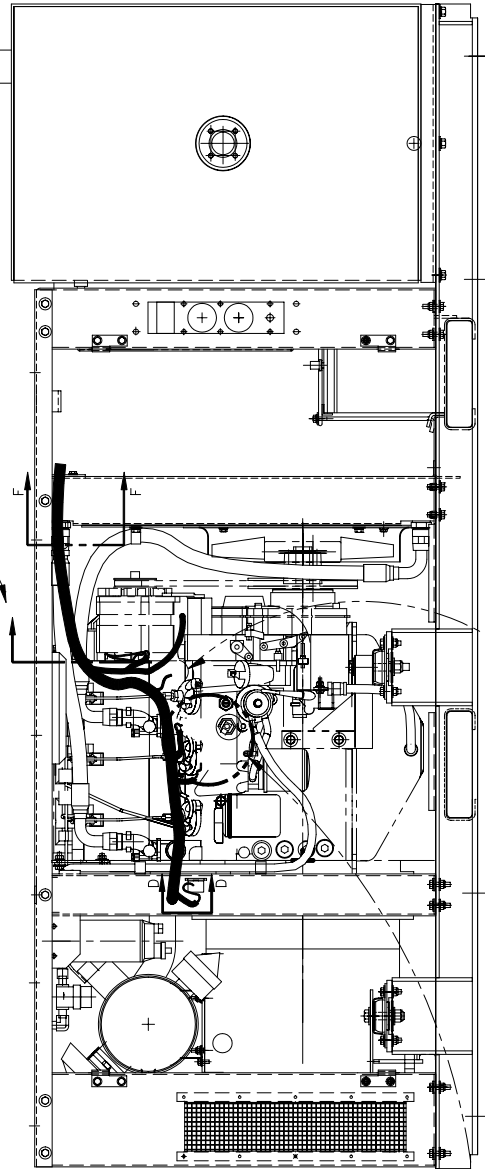
ALTERNATOR CONNECTIONS

INSTALL GROMMET ON  
HARNESS BEFORE PUSHING  
HARNESS INTO SLOT

FUEL RETURN LINE  
FUEL SUPPLY LINE

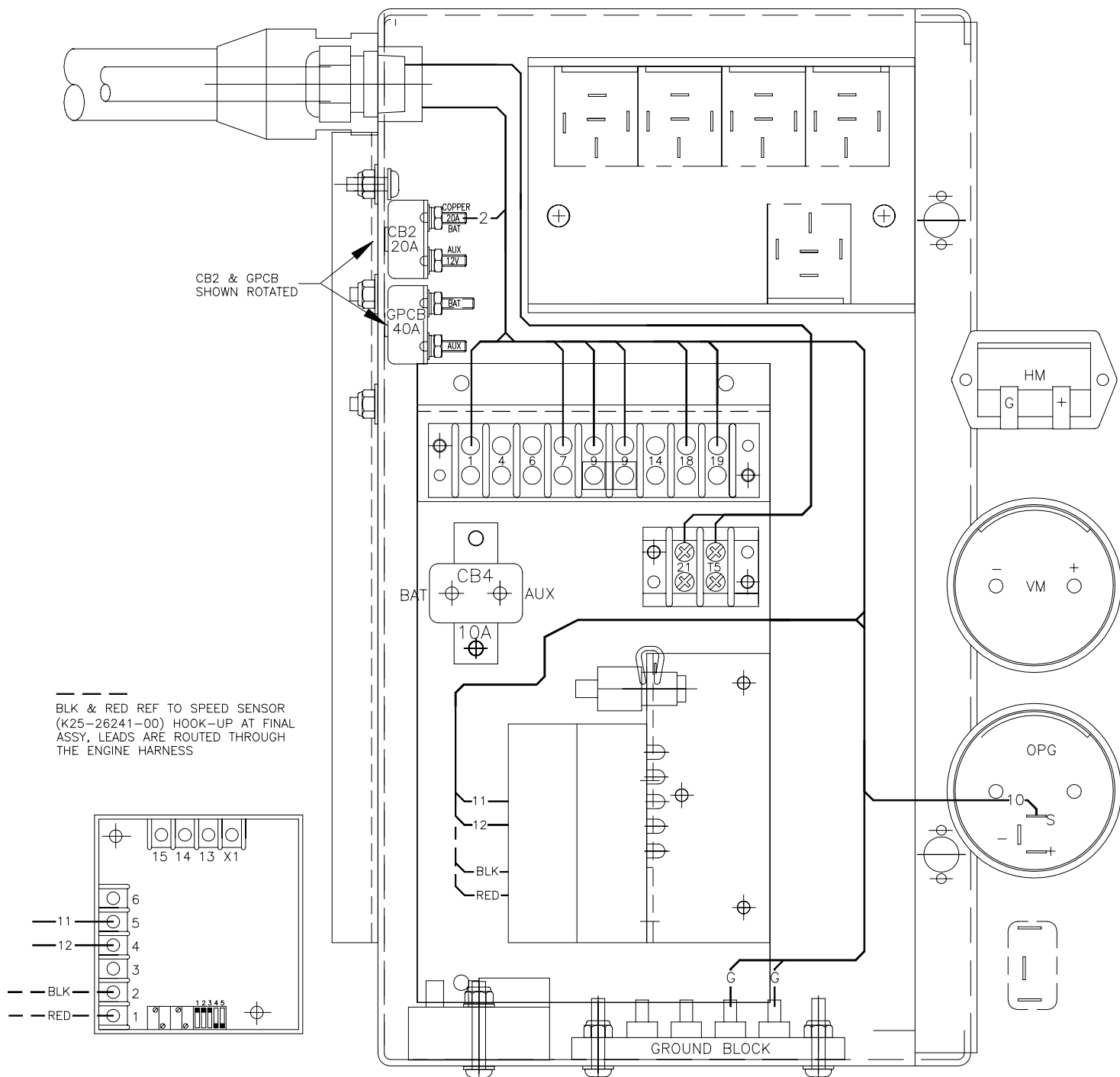


SECTION F-F

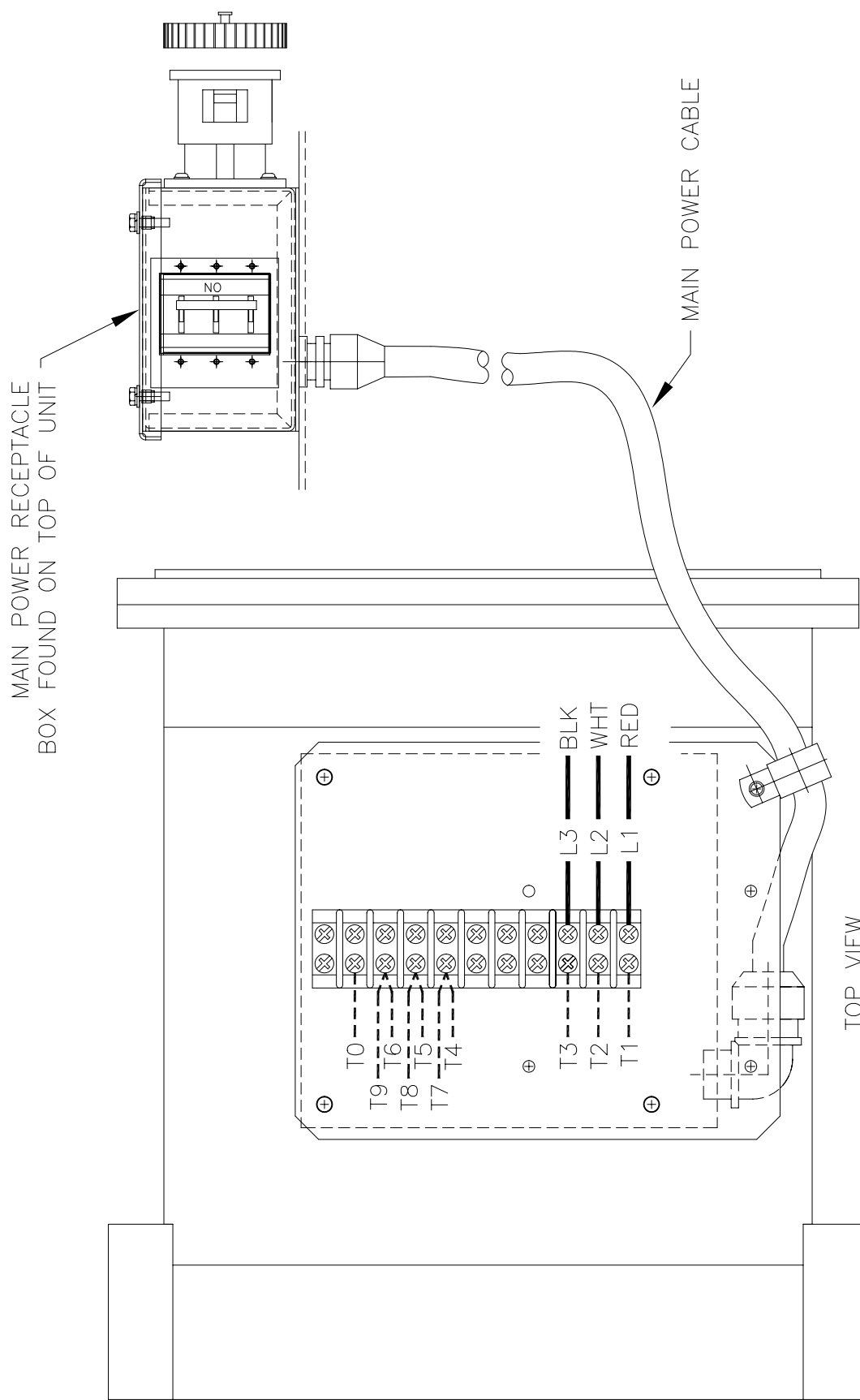


FRONT VIEW

OIL TEMPERATURE SWITCH



**WIRING  
ENGINE HARNESS TO BOX**



GENERATOR  
WIRING

## **SECTION FOUR**

### **MAINTENANCE AND COMPONENT INFORMATION**

#### **4.1 ROUTINE ENGINE MAINTENANCE**

##### **4.1.1 ENGINE OIL**

Should be checked before starting the engine and at pre-trip to insure the oil level is at the "full" mark. Total capacity is 10.6 quarts (10 liters) in oil sump and 3 quarts (2.8 liters) in the oil cooler. Engine should not run for more than 200 hours without checking oil level.

##### **4.1.2 DEUTZ WILL HONOR THE 1000 HOUR CHANGE INTERVAL ONLY IF:**

- a. Engine speed is 1800 rpm and lube oil meets MIL-L-2104D with A.P.I. rating of CF/CF-4, SAE 10W/40 (See Section 3.9 for cold weather operations).
- b. Oil filter cartridge is K26-24898-14 with 5/8-quart (0.6 liter) capacity.
- c. Engine operation is in normal ambients of  $-10^{\circ}\text{C}$  to  $40^{\circ}\text{C}$  ( $14^{\circ}\text{F}$  to  $104^{\circ}\text{F}$ ).

##### **4.1.3 FUEL TANK CAPACITY: 52 GALLONS U.S. (197 liters)**

Diesel fuel used should be premium grade #1 or #2 diesel fuel. Less expensive grades of diesel fuel are available but may reduce injection pump and injector life.

##### **4.1.4 FUEL FILTERS**

- 1- Primary – K22-06904-00 complete / K22-06905-00 Element only.
- 1- Secondary – K26-24898-13.

Use only name brand filter elements, less expensive elements may not perform satisfactorily causing fuel injection pump or injector failure.

##### **4.1.5 BATTERY**

Group 31 - 925 CCA @  $0^{\circ}\text{F}$  ( $-18^{\circ}\text{C}$ ) to supply 12 volts. Reserve capacity 175 minutes.

##### **4.1.6 DIESEL ENGINE TIMING**

The F3M2011 engine has belt driven timing and there is no need for adjustment during normal operation.

It is recommended by Deutz to replace the timing belt and idler pulley every 3000 hours of operation. A replacement kit (XB-DO292-9902) can be ordered but, since the replacement requires special tooling, it is recommended that the replacement should be made by an authorized Deutz repair shop.

##### **4.1.7 INJECTORS**

If an injector is suspected of being faulty, it is recommended that the procedure in the Deutz shop manual be followed. The shop manual lists all procedures and precautions that must be taken when changing the injector.

A faulty injector can be located by loosening each injector line one at a time. When a faulty injector is located, the engine will not sound any different than before that injection line was loosened. Also, no RPM loss will occur when the faulty injector is located. If the injector is sticking, a knocking sound will occur. When injection line of the faulty injector is loosened the knocking sound will stop.

If an injector or an injection pump fails, it is recommended that generator set be taken to an authorized Deutz repair shop for any necessary repairs.

#### 4.1.8 VALVE ADJUSTMENTS

A tune up for any diesel engine consists of adjusting the valve lash and torquing the head bolt while the engine is cold. The shop manual should be followed for the sequence of bolt tightening and the specified torque values. They do vary for two of the bolts that hold the head to the block. The inlet valve clearance is 0.012 inches (0.3 mm); the exhaust valve clearance is 0.020 inches (0.5 mm). The firing order is 1,2,3. Starter maintenance trouble shooting and other information are contained in the Deutz shop manual, or Deutz operators manual for the F3M1011F or F3M2011 Diesel Engine.

#### 4.1.9 BATTERY CHARGER

A 14-15 VDC, 55 amp alternator is used to supply voltage to the control circuit and keep the battery charged after starting. A voltage regulator is built into the alternator. The B+ terminal provides voltage to the control circuit.

## 4.2 STARTING FLUID SYSTEM

### OPERATION

A single glow plug is located in the engine intake manifold. A temperature switch automatically energizes the glow plug when required.

### 4.3 TROUBLE SHOOTING

The following trouble shooting chart is by no means complete, but covers the more general type problems, which would most likely occur if a breakdown is experienced.

POSSIBLE CAUSE	CORRECTIVE ACTION SUGGESTED
<b>Problem: Engine starter will not energize</b>	
Loose or corroded battery terminals	Clean terminals and tighten
Battery voltage too low	Recharge or replace battery
No voltage at starter motor relay terminal (SMR)	Remedy lack of voltage
Faulty starter motor relay (SMR)	Replace
Faulty starter motor (SM)	Replace
Engine too hot Electronic Control Unit (ECU) will not allow starter to operate	Allow engine to cool
Faulty engine oil temperature switch (OTS)	Replace switch
<b>Problem: No voltage at starter motor relay (SMR)</b>	
Faulty "Auto/Off/Man" Switch (SW1)	Replace
Circuit Breaker (CB2) Open	Replace if it does not reset
Relay R1 or R3 faulty	Replace
Engine control unit (ECU) faulty	Replace

POSSIBLE CAUSE	CORRECTIVE ACTION SUGGESTED
<b>Problem: Engine will not start even though starter turns engine over</b>	
No Fuel	Add fuel to tank
Fuel not reaching injectors	Remedy
<b>Problem: Fuel not reaching injectors</b>	
Fuel solenoid not energized	Remedy
Fuel filters clogged	Replace filter elements
Air leaking into fuel system between tank & fuel pump	Repair leak
<b>Problem: Fuel solenoid will not energize</b>	
Relay (R2) faulty	Replace
Engine Control Unit (ECU) faulty	Replace
<b>Problem: Severe knocking from one or more injectors</b>	
Air trapped in injector or injection line	Loosen fuel line at injector and bleed air out while engine is running
Sticking needle or spindle within injector	Loosen and re-torque injector flange bolts to align the injector correctly
<b>Problem: Engine stops with low oil pressure indication</b>	
Oil level too low	Add oil
Oil Pressure Switch (OPS) failed closed	Replace OPS



<b>POSSIBLE CAUSE</b>	<b>CORRECTIVE ACTION SUGGESTED</b>
<b>Problem: Engine stops with high engine temperature indication</b>	
Oil temperature too high	Check cooler for air flow restriction and clean or remove restriction
Oil level too low	Add oil
Engine oil temperature switch failed to closed (OTS).	Replace switch
Too low oil flow through cooler	Eliminate any restriction in lines or cooling coil Check engine pump for oil pressure
<b>Problem: Engine fails to stop when stop switch (SW1) is activated</b>	
Switch (SW1) not closing	Replace
Relay (R2) stuck in energized position	Replace
Engine fuel solenoid (FS) stuck in run position	Replace or repair
<b>Problem: No 460V power at main power receptacle</b>	
Circuit Breaker (CB1) not closed	Turn CB1 on
460V AC generator faulty	See Section 6 Generator



# **SECTION 5**

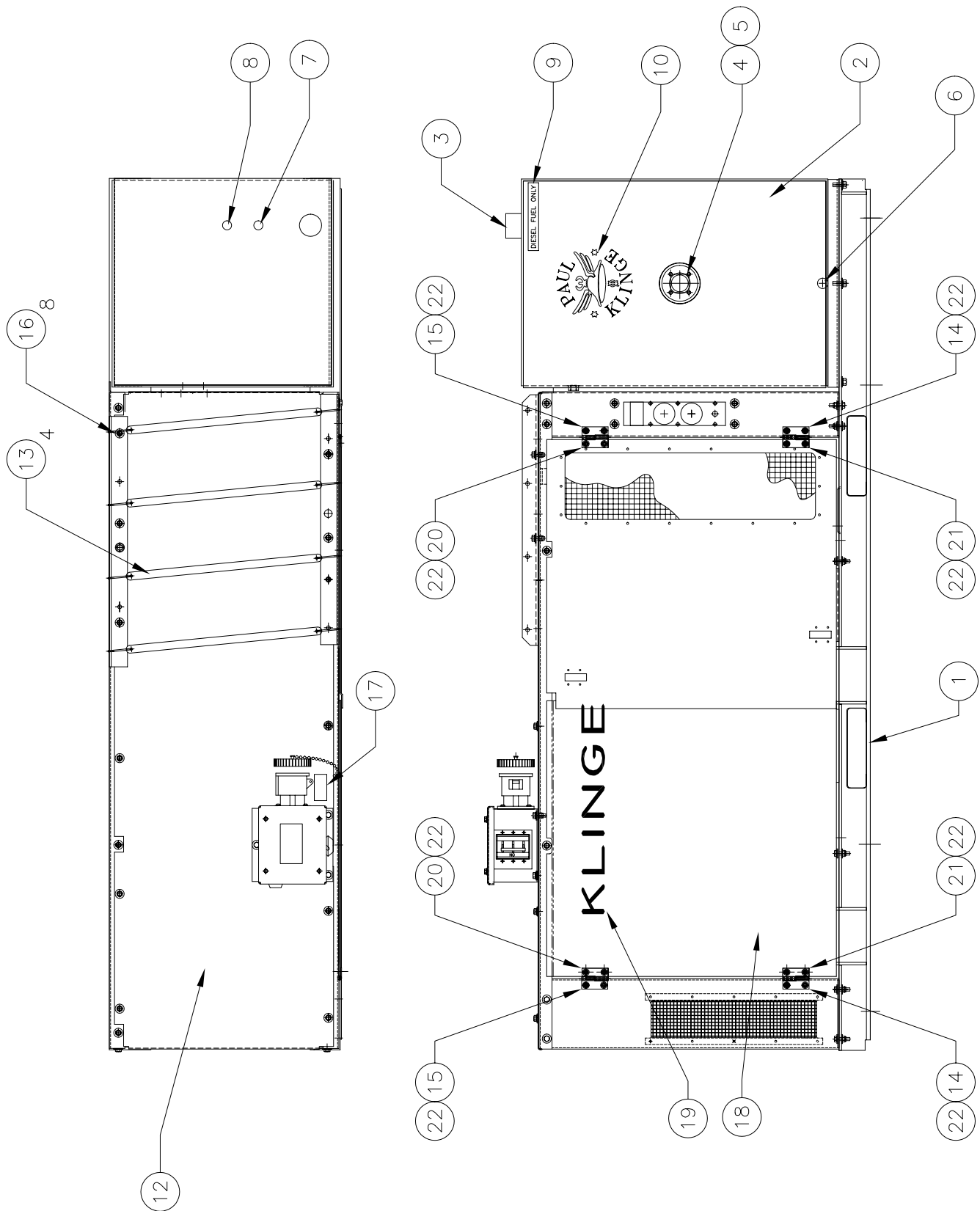
## **SERVICE PARTS**



### **MODEL NMG-115-06**

### **GENERATOR SET**

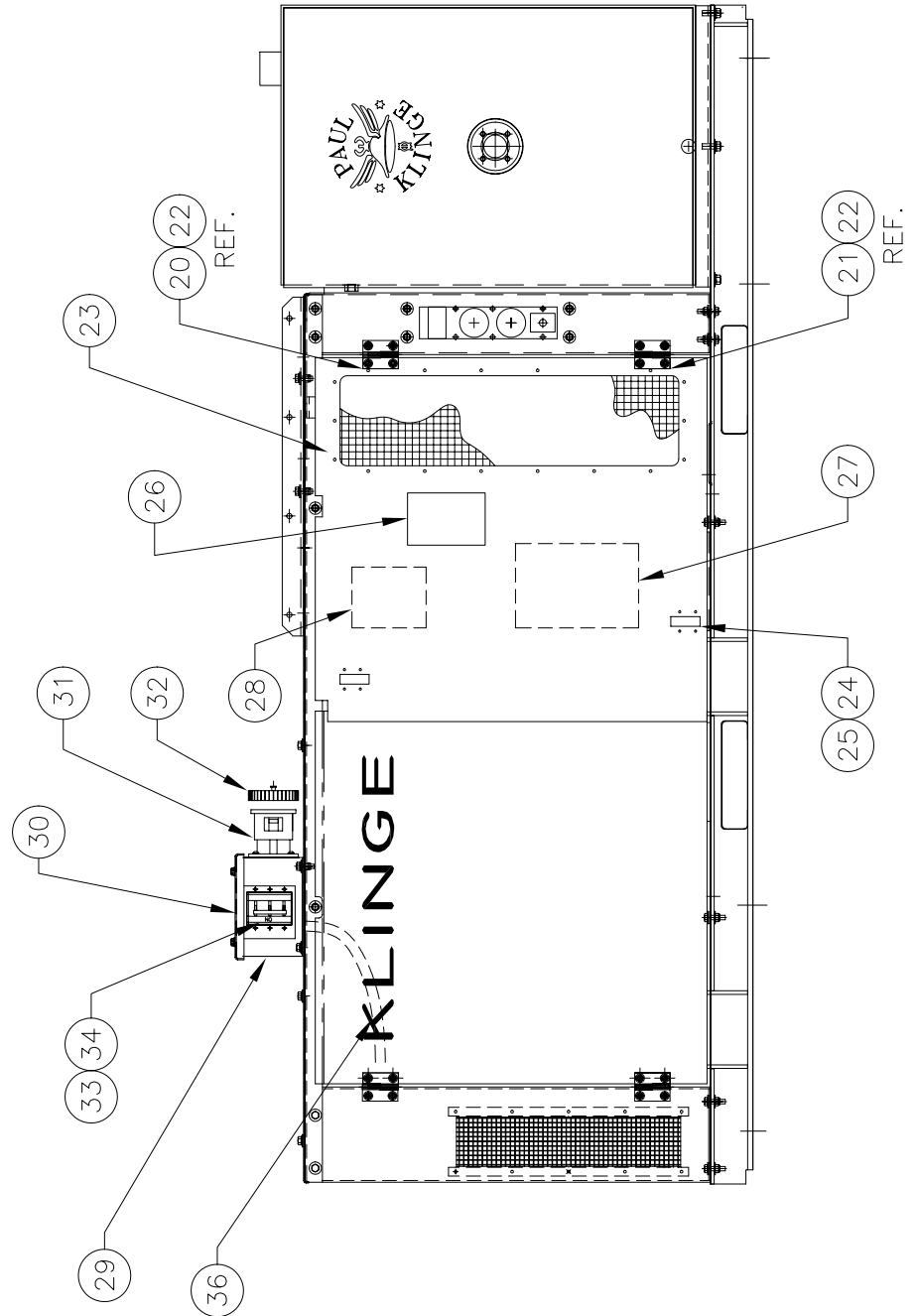
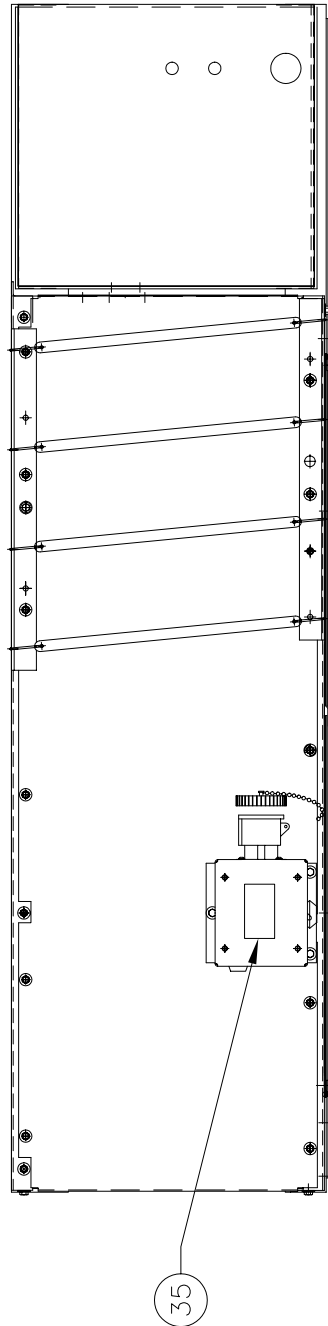
- 5.1A Front Outside View
- 5.1B Front Outside View
- 5.2A Engine Front
- 5.2B Engine Front
- 5.3 Engine Rear
- 5.4 Air Intake System
- 5.5A Engine Control Box Outside View
- 5.5B Engine Control Box Inside View
- 5.6 Fuel System
- 5.7A Exhaust System
- 5.7B Exhaust System
- 5.8 Speed Sensor Replacement
- 5.9 Alternator



SECTION 5.1A  
FRONT OUTSIDE

**SECTION 5.1A****FRONT OUTSIDE**

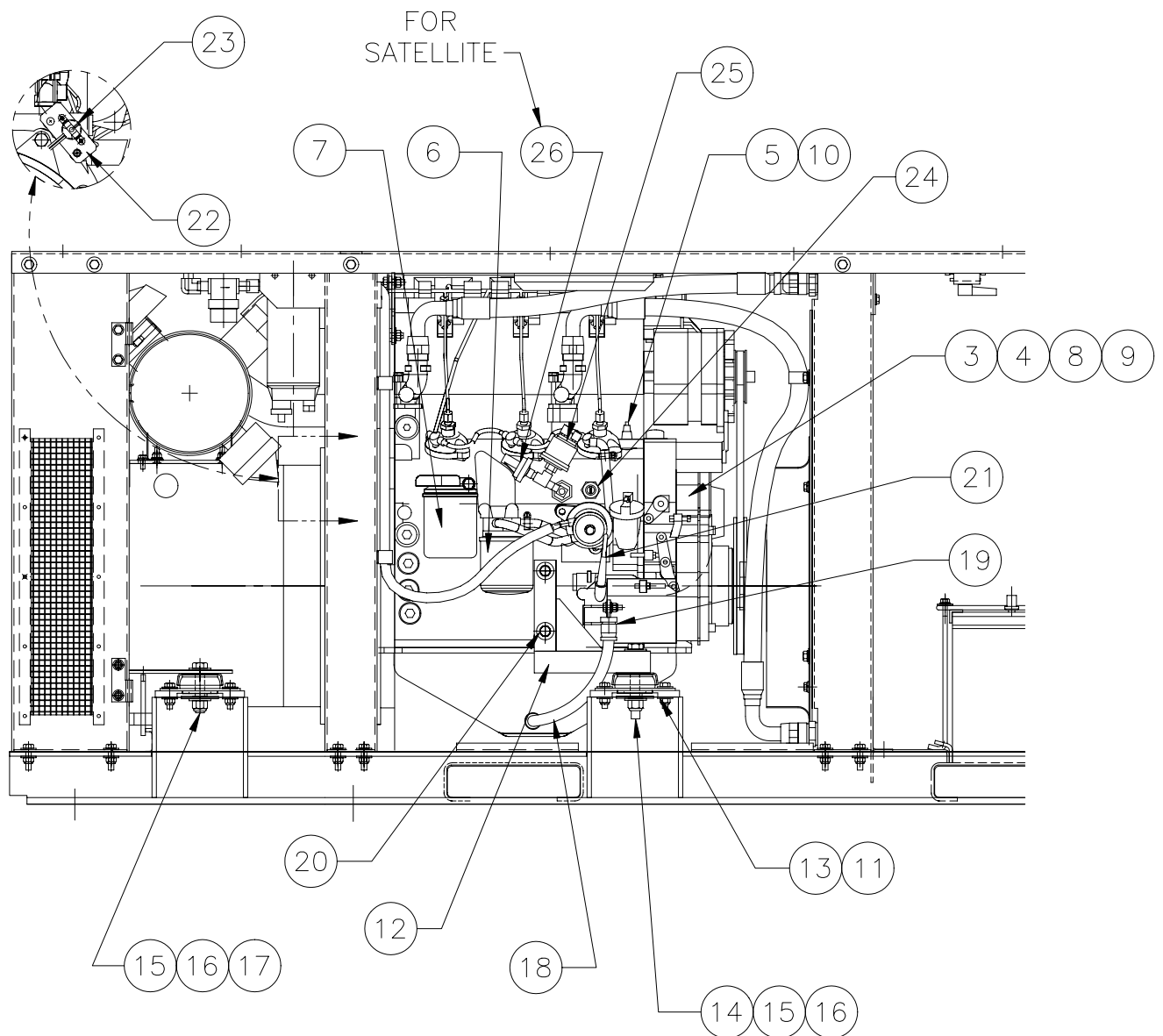
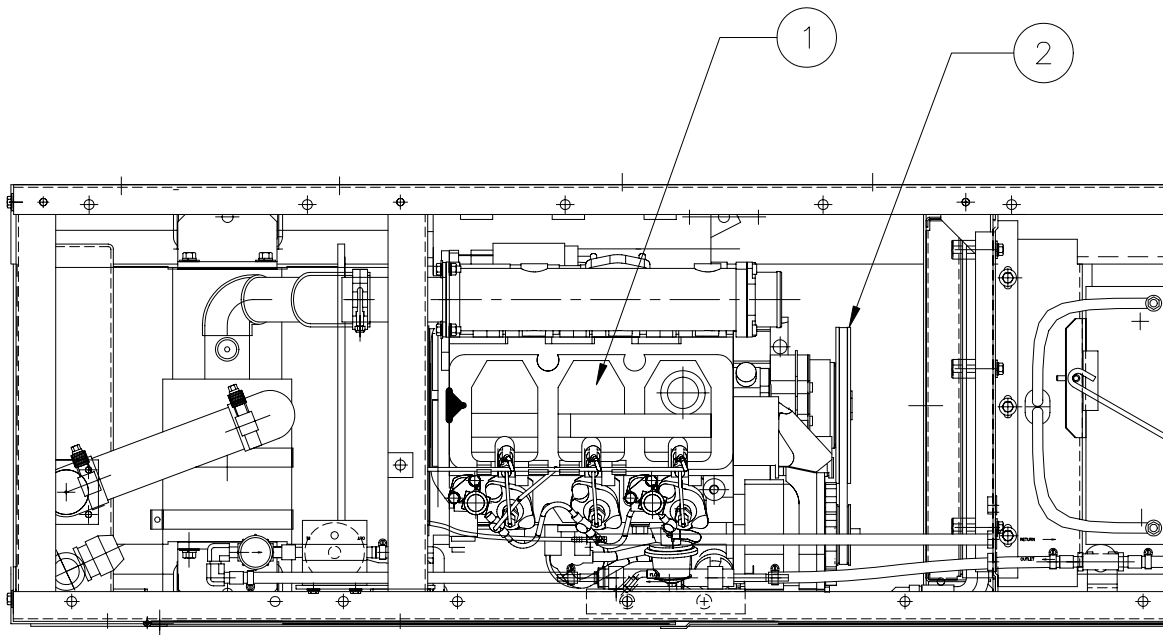
ITEM	PART NO.	DESCRIPTION	QTY.
1	360 12654 00	BASE GENSET NMG-115-02 WITH NUTSERTS	1
2	360 12098 00	TANK FUEL 50 GALLON NMG-115 PAINTED	1
		(INCLUDES ITEMS 3 THRU 10)	
3	K26 24792 00	CAP FUEL PLASTIC 2"FPT WITH 8" CHAIN	1
4	K26 17488 00	GAUGE FUEL TANK	1
5	K26 20590 00	DIAL FUEL GAUGE JR REPLACEMENT	1
6	K23 13044 04	PLUG PIPE SOCKET BRASS 1/2 MPT	1
7	K26 24768 00	VENT FUEL TANK	1
8	K26 24769 00	PLUG FUSIBLE 1/2 MPT	1
9	K35 05745 01	LABEL DIESEL FUEL ONLY BLUE	1
10	K35 51577 00	LABEL LOGO PAUL KLINGE DARK BLUE	1
11	060 10678 00	PANEL REAR WHITE	1
12	060 11765 00	PANEL TOP WHITE	1
13	K28 10691 00	STRAP 15 INCHES LONG NO HOOKS	4
14	K29 17879 01	HINGE SLIP SS 9/32 HOLES SOCKET	2
15	K29 17880 01	HINGE SLIP SS 9/32 HOLES SOCKET	2
16	K29 18490 00	HOOK STRAP SS .125 DIAMETER WIRE	8
17	K35 05713 00	LABEL 460 VAC-3 PH-60 HZ	1
18	360 10786 00	DOOR ASSEMBLY LEFT HAND	1
		(INCLUDES ITEMS 19 THRU 22)	
19	K35 05743 01	LABEL KLINGE BLUE	1
20	K29 17879 02	HINGE SLIP SS 9/32 HOLES WITH PIN	2
21	K29 17880 02	HINGE SLIP SS 9/32 HOLES WITH PIN	2
22	060 09113 00	INSULATOR HINGE	8



SECTION 5.1B  
FRONT OUTSIDE

**SECTION 5.1B****FRONT OUTSIDE**

ITEM	PART NO.	DESCRIPTION	QTY.
23	360 12243 02	DOOR ENGINE END NMG-115-04	1
		(INCLUDES ITEMS 20, 21, 22 & 24 THRU 28)	
24	K29 18502 00	LATCH TRIGGER SS	1
25	060 09114 00	INSULATOR LATCH WHITE PVC	2
26	K35 05919 00	LABEL OPERATING INSTRUCTIONS NMG-115-04	1
27	K35 05915 03	LABEL ELECTRICAL SCHEMATIC NMG115-04	1
28	K35 05742 00	LABEL MAINTENANCE SCHEDULE ENGINE	1
29	360 10783 02	RECEPTACLE BOX MAIN POWER	1
		(INCLUDES ITEMS 30, 31 & 33 THRU 36)	
30	060 10759 00	COVER RECEPTACLE BOX WHITE	1
31	K25 26022 00	RECEPTACLE POWER 32A 440V 3P+G	1
		(INCLUDES ITEM 32)	
32	K25 26143 00	CAP W/CHAIN	1
33	K24 22098 00	CIRCUIT BREAKER 25 AMP 3 POLE 277/480V	1
34	K28 10785 00	SHIELD CIRCUIT BREAKER KIT 1.03 CENTER	1
35	K35 05683 00	LABEL DANGER HIGH VOLTAGE 3.5x5	1
36	360 10784 01	CABLE MAIN POWER	1



**SECTION 5.2A**  
**ENGINE FRONT**

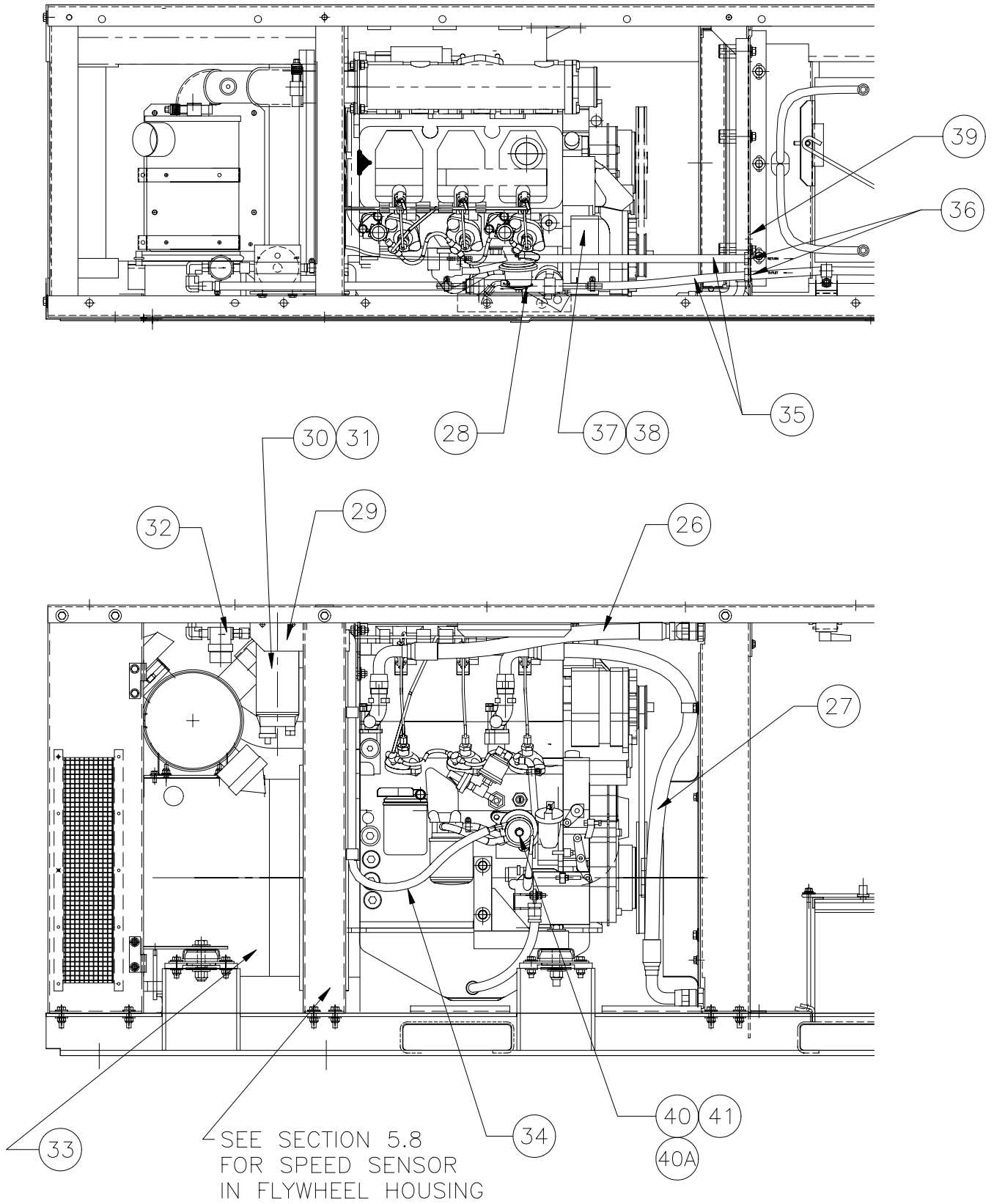


**SECTION 5.2A****ENGINE FRONT**

ITEM	PART NO.	DESCRIPTION	QTY.
1	K26 25130 00	ENGINE DEUTZ F3M2011	1
		( NMG-115-06 UNITS SERIAL 2785 AND UP)	
2	K26 24898 10	BELT 12 V ALT F3LIOIE	1
3	K26 24898 09	SOLENOID FUEL SHUT DOWN NORMALY OPEN	1
4	K26 24898 11	RECEPTACLE DIN TYPE CORD END	1
5	K26 24898 12	SWITCH SENDER OIL TEMP 130 DEGREE	1
6	K26 24898 13	ELEMENT FUEL FILTER F3LIOIE	1
7	K26 24898 14	ELEMENT OIL FILTER F3LIOIE	1
8	K26 24898 15	SEAL O-RING	1
9	K26 24898 16	SPRING	1
10	K26 24898 17	RING SEAL	1
11	K21 16318 00	CUP ISOLATOR SNUBBING WHITE	1
12	360 12216 01	MOUNTING FEET ENGINE INJECTION SIDE NMG-115	1
13	K28 10825 00	ISOLATOR NEOPRENE ENGINE GREEN W/FLAG	4
14	K21 16221 00	SCREW HEX SS 1/2-13 X 4	2
15	K21 14074 00	WASHER FLAT SS 1/2 .56 ID 1.38 OD	8
16	K21 14921 11	NUT LOCK SS 1/2-13	4
17	K21 14062 00	SCREW HEX SS 1/2-13 X 2-3/4	1
18	360 10220 03	HOSE OIL DRAIN 8"LG	1
19	360 10195 00	RETAINER OIL DRAIN	1
20	K26 24898 03	BOLT HEX M14-2 X 55 GR 10.9	4
21	K26 25135 14	DIP STICK EXTENDED LENGTH 10" OIL PAN	1
22	060 12309 00	BRACKET TEMPERATURE SWITCH MOUNTING WHITE	1
23	K25 14331 00	CONTROL TEMPERATURE 55F OPEN 40F CLOSE	1
24	XB-DO118-2482	OIL PRESSURE SWITCH 1.5 BAR = 22PSI	1
25	K26 24935 00	SENDER OIL PRESSURE 1-150 PSI	1

**FOR SATELLITE ONLY**

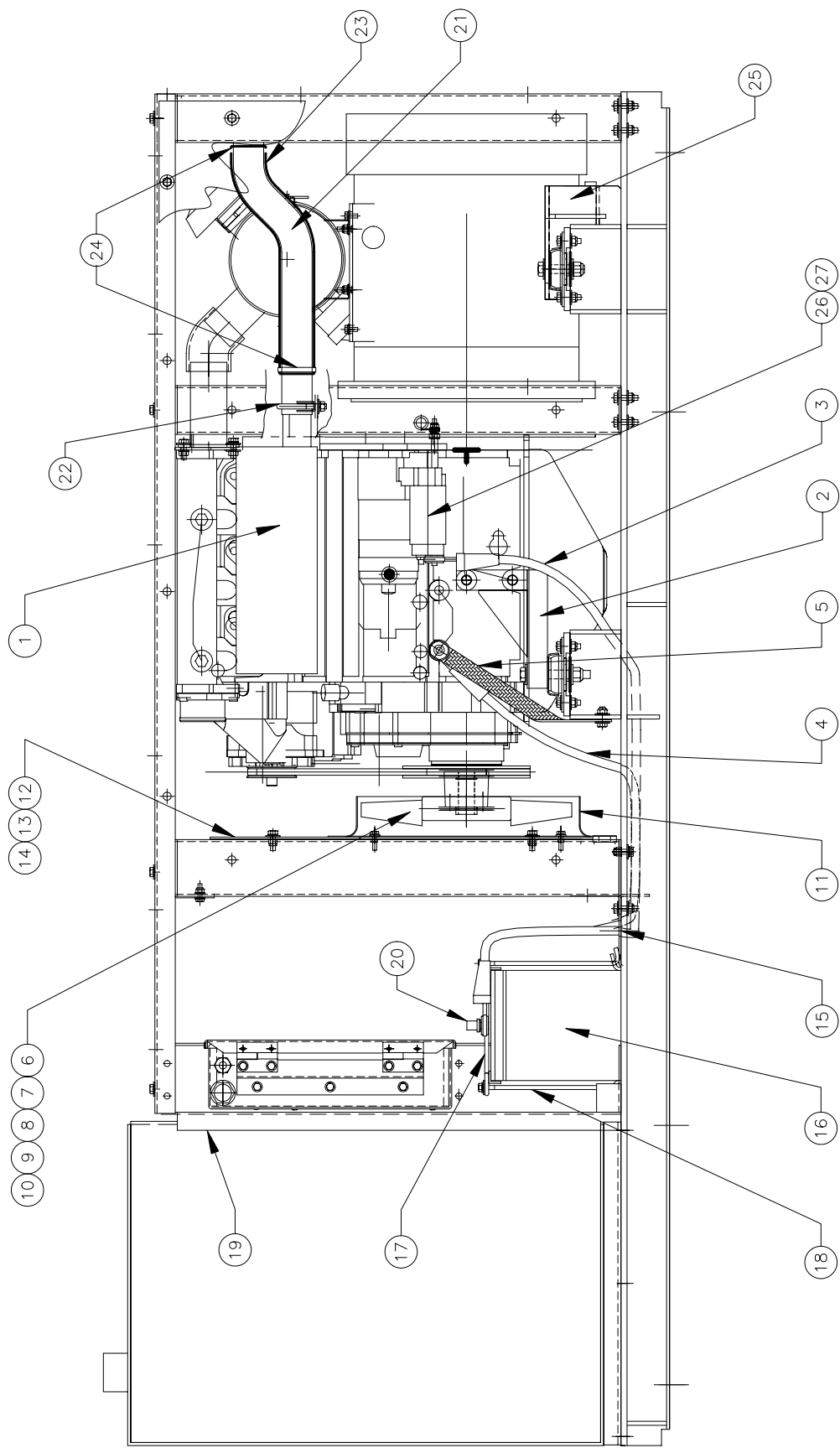
26	K24 22099 00	SWITCH PRESSURE 15 PSI SPDT 1/8 MPT	1
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**SECTION 5.2B**  
**ENGINE FRONT**

**SECTION 5.2B****ENGINE FRONT**

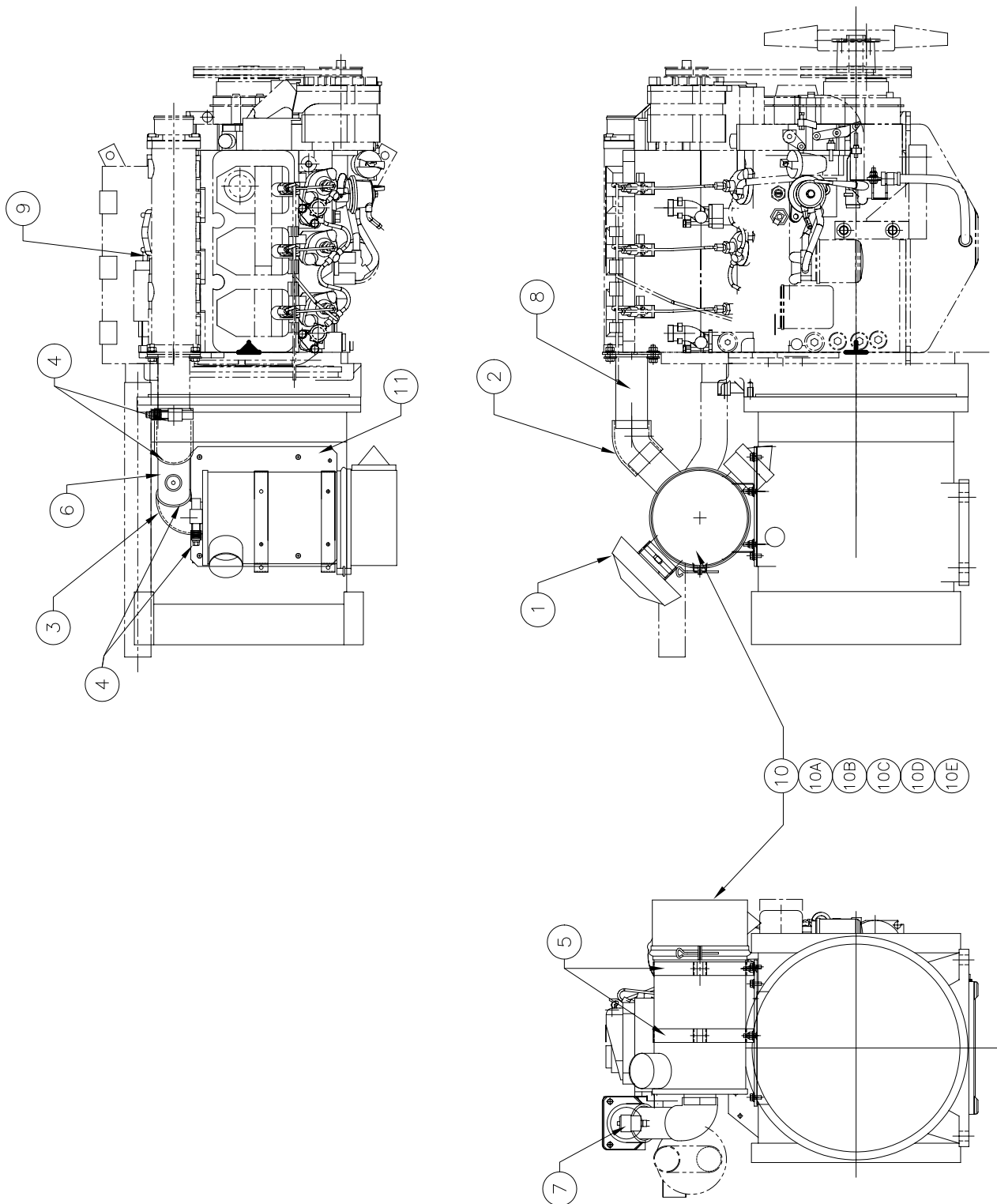
ITEM	PART NO.	DESCRIPTION	QTY.
26	K26 24891 00	HOSE LUBE OIL 3/4 JIC FLARE	1
27	K26 24890 00	HOSE LUBE OIL 3/4 JIC FLARE	1
28	K25 25917 00	HEATER FUEL 150 W 12 VDC 6 GPM	1
29	K22 06888 00	HEAD FILTER M16-1.5 (2)1/4 FPT	1
30	K22 06904 00	FILTER FUEL PRIMER WITH BOWL M16 3OG	1
31	K22 06905 00	FILTER WATER/FUEL ELEMENT M16 3OM	1
32	K26 24787 00	STRAINER FUEL 1/4 MPT WHITE	1
33	XB-997872	ALTERNATOR LIMA MAC	1
34	K28 10804 04	HOSE NEOPRENE 1/4 ID PUSH-LOCK	3.1 FT
35	K28 10804 05	HOSE NEOPRENE 5/16 ID PUSH-LOCK	8.4 FT
36	K25 10209 00	BUSHING SNAP .88 MOUNTING HOLE	2
37	K26 25135 16	VOLTAGE REG BATT CHRG ALTERN	1
38	K26 25135 15	ALTERNATOR 12V 55A F3M2011 ENG	1
39	K28 10847 05	GROMMET INSERT 1" HOLE SIZE	1
40	K26 25130 10	PUMP FUEL SUPPLY	1
40A	K26 25135 12	PUMP FUEL SUPPLY F3M2011	1
41	K26 25135 13	O-RING FUEL SUPPLY PUMP	1



**SECTION 5.3**  
**ENGINE REAR**

**SECTION 5.3****ENGINE REAR**

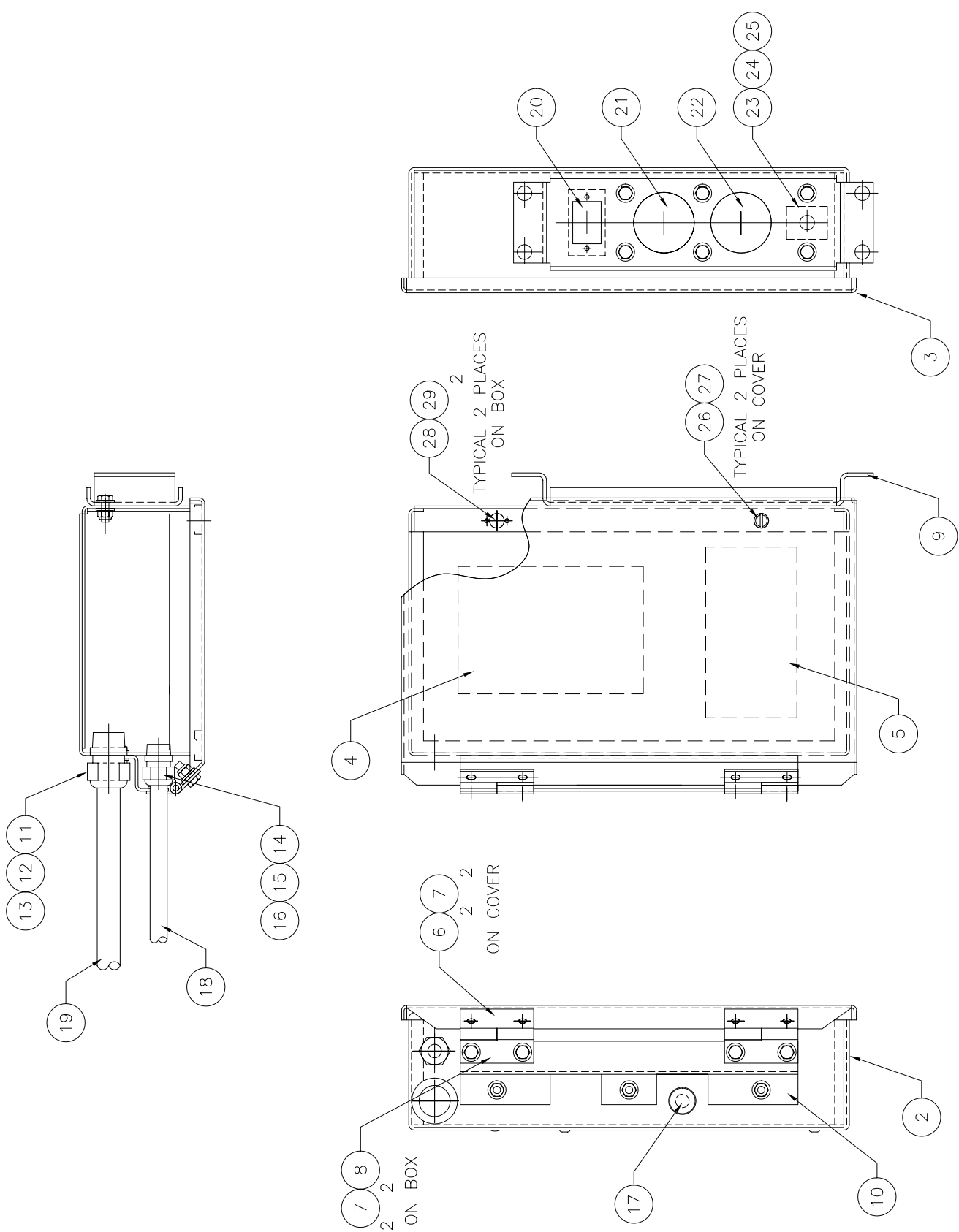
ITEM	PART NO.	DESCRIPTION	QTY.
1	K26 24875 00	MUFFLER MANIFOLD 30011	1
2	360 12212 00	MOUNTING FEET STARTER SIDE NMG	1
3	K25 25928 11	CABLE BATTERY #1/0 X 54 RED SEALED	1
4	K25 25928 12	CABLE BATTERY #1/0 X 42 BLACK SEALED	1
5	K25 25900 00	STRAP GROUND 12"	1
6	K26 24898 04	HUB	1
7	K26 24898 05	BOLT HUB MOUNTING	4
8	K26 24898 06	FAN	1
9	K26 24898 07	BOLT FAN MOUNTING	4
10	K26 24898 08	WASHER DISK	1
11	K26 24873 00	ORIFICE FAN F31-1011E WHITE	1
12	360 12020 00	PLENUM OIL COOLER WHITE	1
13	K26 24955 00	OIL COOLER 9 TUBE	1
14	K26 24882 00	KIT OIL COOLER MOUNTING	3
15	K28 04714 00	GROMMET NEOPRENE 1.38 X 1.63 H X .1	2
16	K25 25912 00	BATTERY 12V 3/8 STUDS 625 CCA	1
17	K29 18541 00	HOLD-DOWN BATTERY	1
18	K29 18542 00	ROD BATTERY HOLDDOWN	2
19	360 11756 00	PANEL TANK END WHITE	1
20	K25 25927 00	NUT BATTERY SEALING 3/8-16	2
21	K26 24889 00	PIPE EXHAUST SS 1.88 DIA	1
22	K21 14751 00	CLAMP EXHAUST CAD PLATED 1-3/4"	1
23	XB-995029-24	SLEEVING 24" LONG	1
24	XB-999057	CLAMP, HOSE	2
25	360 13800 00	CRADLE ALTERNATOR	1
26	K26 25135 17	STARTER 12V 2.3KW F3M2011 ENGINE	1
27	K26 24898 90	SOLENOID ELECTRIC 0START 12 V F-MOD	1



SECTION 5.4  
AIR INTAKE SYSTEM  
NMG-115-04

**SECTION 5.4****AIR INTAKE SYSTEM**

ITEM	PART NO.	DESCRIPTION	QTY.
1	K26 25095 04	HOOD AIR INLET PLASTIC	1
2	K28 10840 00	ELBOW NEOPRENE 45 2-1/4	1
3	K28 10838 00	ELBOW NEOPRENE 90 2-1/4 SMALL RADIUS	1
4	K21 16379 09	CLAMP CONSTANT TORQUE SS 2-1/4	4
5	K26 24667 00	BAND AIR CLEANER MOUNTING 6.5"ID	2
6	360 10780 01	TUBE 2-1/4 X 5 MODIFIED COMBUSTION AIR	1
7	K26 24666 00	INDICATOR AIR RESISTANCE	1
8	360 10778 00	ADAPTER 2-1/4 COMBUSTION AIR BLACK	1
9	K26 24898 46	GLOW PLUG ELECTRIC STARTING ACC 12	1
10	K26 25091 01	FILTER AIR 1 STAGE 2.5-2.25 MODIFIED	1
10A	K26 25091 05	BAFFLE PLASTIC	1
10B	K26 25091 06	CLAMP AIR FILTER	1
10C	K26 25091 07	CUP DUST	1
10D	K26 25091 08	ELEMENT FILTER AIR PRIMARY EXTENDED	1
10E	K26 25091 09	NUT WING	1
11	360 13808 00	SUPPORT AIR FILTER WITH STUDS	1

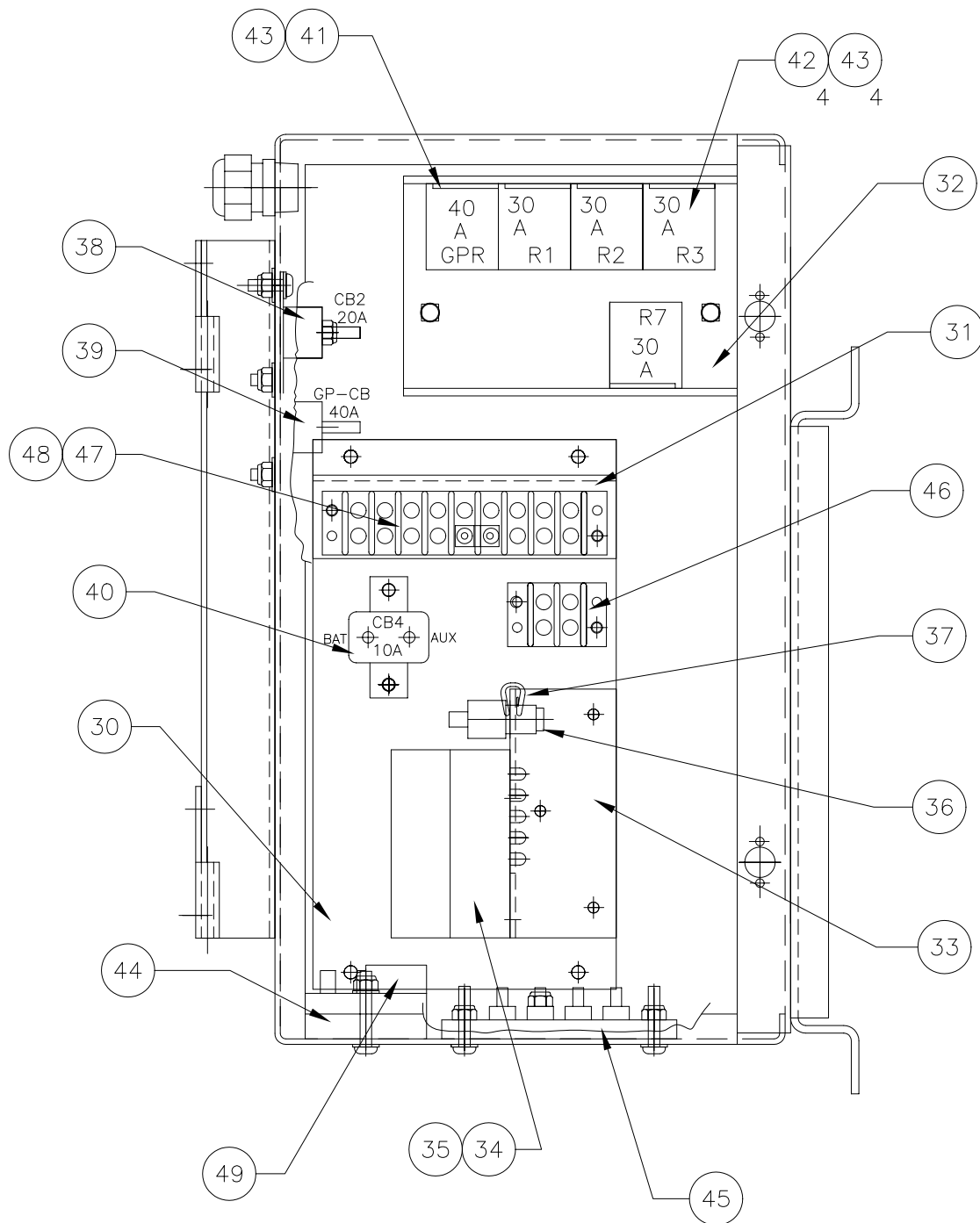


SECTION 5.5 A  
ENGINE CONTROL BOX  
OUTSIDE VIEW



**SECTION 5.5 A****ENGINE CONTROL BOX**

ITEM	PART NO.	DESCRIPTION	QTY.
1	360 12255 03	BOX ENGINE CONTROL COMPLETE	1
		(INCLUDES ITEMS 2 THRU 48)	
2	360 12234 01	BOX ELECTRICAL NMG-115 WHITE	1
3	360 12681 03	COVER ELECT BOX NMG-115-04/05	1
		(INCLUDES ITEMS 4 THRU 7)	
4	K35 05915 03	LABEL SCHEMATIC NMG-115-04/05	1
5	K35 06158 03	LABEL COMPONENT LAYOUT NMG-115-04/05	1
6	K29 17879 02	HINGE SLIP SS 9/32 HOLES WITH PIN	2
7	060 09113 00	INSULATOR HINGE ELECT BOX WHITE	4
8	K29 17879 01	HINGE SLIP SS 9/32 HOLES SOCKET	2
9	060 11755 00	CHANNEL ELECT BOX WHITE	1
10	060 11754 01	SUPPORT HINGE ELECT BOX WHITE	1
11	K25 19612 03	CONNECTOR STRAIGHT 3/4 (54-69)	1
12	K25 26340 03	NUT LOCK CONDUIT BLACK NYLON 3/4 NPT	1
13	K25 22534 02	RING SEAL SS 3/4 CND	1
14	K25 26129 03	CONNECTOR STRAIGHT PLASTIC SHORT 1/2x.27-	1
15	K25 26340 02	NUT LOCK CONDUIT BLACK NYLON 1/2 NPT	1
16	K25 26147 01	RING SEAL PLASTIC 1/2 CONDUIT	1
17	K28 10936 08	PLUG SEAL POLY FLUSH .88 HOLE	1
18	360 12699 01	CABLE BATTERY CHARGER DISCONNECT NMG-115	1
19	360 12285 01	WIRING ENGINE HARNESS NMG-115-04	1
20	K25 22099 00	HOURLMETER 10-32 VDC FOR AC ADD	1
21	K25 26090 00	VOLTMETER 0-16 VDC	1
22	K26 24934 00	GAUGE OIL PRESS 0-150 PSI BLACK	1
23	K24 22339 00	SWITCH TOGGLE SPDT ON-OFF-ON	1
24	K24 17239 00	BOOT TOGGLE SWITCH	1
25	K35 06130 00	LABEL PANEL SWITCH AUTO-MAN	1
26	K21 15393 00	SCREW RETAINING #12	2
27	K21 16316 00	SCREW CAPTIVE SS #12 SLOT	2
28	K21 14682 00	RECEPTACLE FASTENER #12 SCREW RIVET TYPE	2
29	K21 15376 00	RIVET SS 1/8 (.12-19) DOME HEAD	4



SECTION 5.5 B  
ENGINE CONTROL BOX  
INSIDE VIEW

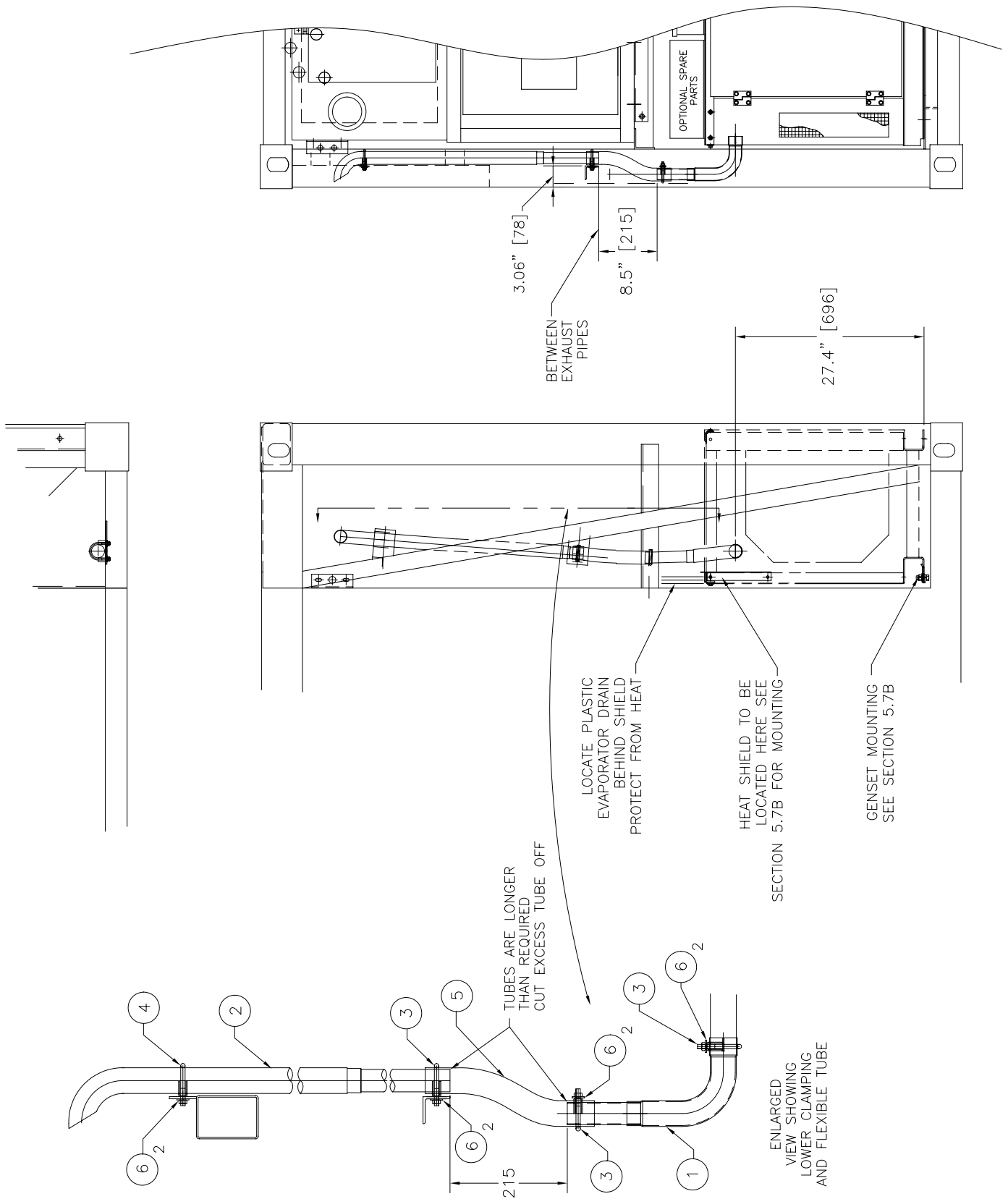
**SECTION 5.5 B****ENGINE CONTROL BOX**

ITEM	PART NO.	DESCRIPTION	QTY.
30	360 13551 00	PLATE SUBPANEL ASSEMBLY WITH NUTSERT	1
31	060 11161 00	ANGLE TERM BLOCK MOUNTING WHITE	1
32	060 12308 00	SUPPORT RELAY WHITE	1
33	060 13544 00	BRACKET AUTO ENGINE CONTROL WHITE	1
34	K31 00826 00	MODULE ENGINE CONTROL ECU	1
35	K35 06127 00	LABEL AUTO ENGINE CONTROL	1
36	K24 16610 00	SWITCH PUSH BUTTON SPST MOM CLOSED	1
37	K28 08849 00	MOLDING TRIM .07/.15 THK	3"
38	K24 22055 00	CIRCUIT BREAKER 20 AMP 1 POLE 12 VDC	1
39	K24 22193 00	CIRCUIT BREAKER 40 AMP 1 POLE 6-12 VDC	1
40	K24 22234 00	CIRCUIT BREAKER 10 AMP 1 POLE 12 VDC	1
41	K24 22119 00	RELAY 12 VDC SPST 40 A	1
42	K24 22121 00	RELAY 12 VDC SPDT 30A	4
43	K25 26109 00	SOCKET RELAY PANEL MOUNTING 12DC	5
44	K24 22337 00	TIMER ADJUSTABLE 12VDC MAKE ON BREAK	1
45	K25 26040 00	BUS BAR 4 GANG #10-32 STUDS	1
46	K25 21619 02	BLOCK TERM 6-32 2P	1
47	K25 21619 09	BLOCK TERM 6-32 9P	1
48	K25 10444 00	JUMPER TERM BLOCK #6 SCREW	1
49	K25 26048 00	RESISTOR VARIABLE - TIME ADJUSTING	1



**SECTION 5.6****FUEL SYSTEM**

ITEM	PART NO.	DESCRIPTION	QTY.
1	060 10851 01	HOSE 5/16 ID X 17 LG	1
2	060 10851 11	HOSE 5/16 ID X 6.6 LG	1
3	060 10851 03	HOSE 5/16 ID X 28 LG	1
4	060 10851 12	HOSE 5/16 ID X 9.75 LG	1
5	060 10851 10	HOSE 5/16 ID X 38 LG	1
6	060 10851 14	HOSE 1/4 ID X 40 LG	1
7	K28 10842 01	FTG HOSE CONNECTOR 1/4 - 3/16	1
8	K23 14000 06	FTG STR BARB 5/16x1/4 FPT BRS	1
9	K23 10280 00	CLAMP HOSE .38-.63 5/16 WIDE	13
10	K23 13020 05	FTG STR BARB 5/16x1/4 MPT BRS	1
11	K23 13023 03	FTG 90 BARB 1/4 X 1/4 MPT	1
12	K23 13023 04	FTG 90 BARB 5/16 X 1/4 MPT	1
13	K23 13039 03	FTG 90 ST BRS 1/4 MPT X FPT	2
14	K23 13060 03	ADPT BRS 1/4 MPT X 1/4 FPT	1
15	060 10851 13	HOSE 5/16 ID X 40 LG	1



SECTION 5.7A  
EXHAUST SYSTEM

**SECTION 5.7A****EXHAUST SYSTEM**

ITEM	PART NO.	DESCRIPTION	QTY.
1	360 11008 00	PIPE EXHAUST BOTTOM	1
2	360 11009 00	PIPE EXHAUST TOP	1
3	K21 14751 00	CLAMP EXHAUST CAD PLATED 1-3/4"	3
4	K21 14744 00	CLAMP EXHAUST CAD PLATED 1-7/8"	1
5	K26 20587 00	HOSE FLEX METAL 1-5/8 x 13 INCHES	1
6	K21 16216 00	WASHER FLAT SS 5/16 (.69 OD) NARROW	8

USE EXISTING  
HARDWARE  
SUPPLIED WITH  
GENSET

10

15

13

16 14

VIEW SHOWING  
HEAT SHIELD MOUNTING

ATTACH ITEM THIS SIDE  
BEFORE INSTALLING GENSET

9  
2

11

12

17  
2

7  
2

8  
2

8  
2

VIEW SHOWING  
GENSET MOUNTING

9  
4

8  
4

8  
4

7  
4

# SECTION 5.7B EXHAUST SYSTEM



**SECTION 5.7B****EXHAUST SYSTEM**

ITEM	PART NO.	DESCRIPTION	QTY.
7	K21 14921 11	NUT LOCK SS 1/2-13	6
8	K21 14074 00	WASHER FLAT SS 1/2 .56 ID 1.38 OD	12
9	K21 14061 00	SCREW HEX SS 1/2-13 X 1-1/2 FULLY THREADED	6
10	060 10946 00	SHIELD HEAT PAINT WHITE	1
11	060 03126 00	CLIP MOUNTING ENGINE GENERATOR WHITE	1
12	060 03127 00	SPACER ENGINE GENERATOR WHITE	1
13	K21 14059 00	SCREW HEX SS 5/16-18 X 1"	1
14	K21 14072 00	WASHER FLAT SS 5/16 .38 ID .88 OD	1
15	K21 14761 00	WASHER LOCK SPG SS 5/16 HEAVY	1
16	K21 50492 04	WASHER INSULATED PVC 5/16	1
17	K21 14070 00	WASHER LOCK SPG SS 1/2	6

#2 NOTE:

INSERT SENSOR UNTIL LIGHTLY TOUCHING  
FLYWHEEL TOOTH (CAREFUL NOT TO DAMAGE SENSOR)  
BACKOUT SENSOR 1/2 TURN, LOCK SENSOR INTO  
POSITION WITH LOCKNUT.

SENSOR TO BE  
CENTERED ON  
FLYWHEEL TEETH

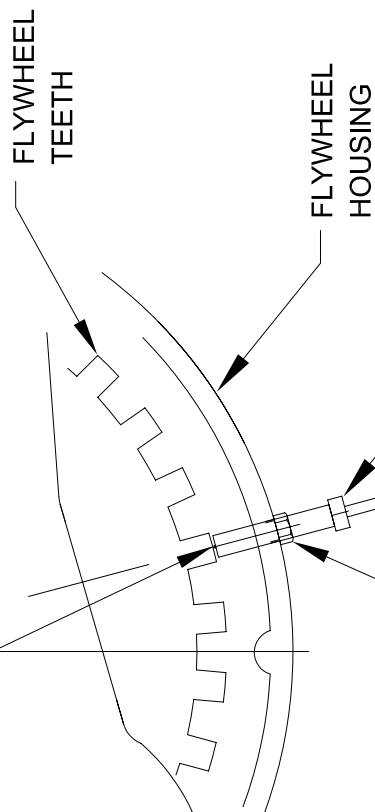
#1 NOTE:

CAUTION:

HIGHPOINT OF A TOOTH MUST BE ALIGNED  
WITH CENTER OF HOLE THAT SENSOR  
WILL BE MOUNTED IN.

ENGINE  
SIDE

GENERATOR  
SIDE



1

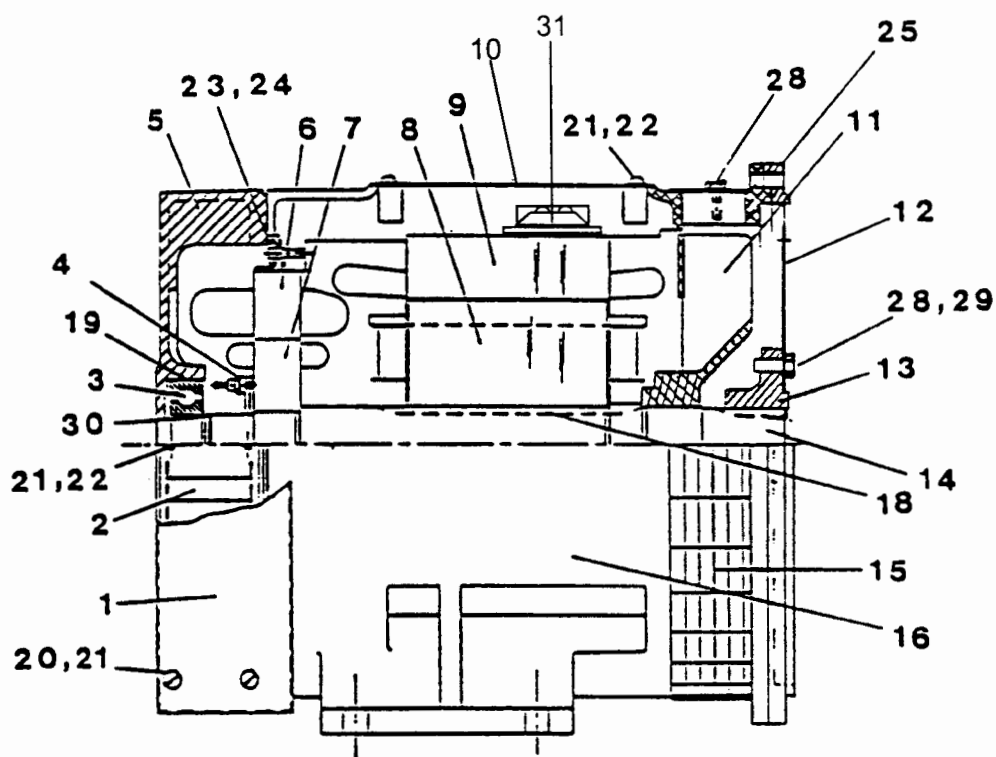
2

LOCKNUT  
3/8-24 UNF

SECTION 5.8  
REPLACEMENT OF  
ENGINE SPEED SENSOR MOUNTED  
ON THE FLYWHEEL HOUSING

**SECTION 5.8****REPLACEMENT OF SPEED SENSOR**

ITEM	PART NO.	DESCRIPTION	QTY.
1	K25 26241 00	SENSOR MAGNETIC SPEED 3/8-24 WITH 6' LEAD	1
2	K21 16454 01	SCR HEX SS 3/8-24 X 1/2	1



SECTION 5.9  
ALTERNATOR

**SECTION 5.9****ALTERNATOR**

ITEM	PART NO.	DESCRIPTION	QTY.
1	XB-L720214-01	DRIP COVER SIDE VENT	2
2	XB-L720213-01	LOUVERED PANEL SIDE VENT	2
3	XB-L831857-01	BEARING	1
4	XB-L778714-OA	RECTIFIER ASSEMBLY AND DIODES	2
5	XB-L703219-01	BEARING CARRIER	1
6	XB-L789412-0A	EXCITER STATOR	1
7	XB-L791164-0A	EXCITER ROTOR	1
8	XB-L786362-0A	MAIN ROTOR	1
9	XB-L783924-0A	MAIN STATOR	1
10	XB-718356-01	COVER PLATE CONNECTION BOX	1
11	XB-L716407-01	FAN ASSEMBLY	1
12	XB-L702806-01	DRIVE DISC ASSEMBLY	2
13	XB-L707336-01	DRIVE HUB	1
14	XB-L701827-01	SHAFT	1
15	XB-L720363-0A	COVER BAND ASSEMBLY	1
16	XB-706227-01	FRAME	1
17		INTENTIONALLY LEFT BLANK	
18	XB-L809865-02	KEY DRIVE HUB 3/8 X 3/8 X 1.63	1
19	XB-L865876-01	O-RING	1
20	K21-16415-02	HEX HEAD SCREW 1/4-20 X 1-1/2	8
21	XB-991804	LOCKWASHER, SPLIT 1/4 SS	16
22	K21-14642-00	SLOT ROUND HEAD SCREW 1/4-20 X 1/2	8
23	K21-13992-00	HEX HEAD CAP SCREW 5/16-18 X 1 GR5	4
24	XB-991805	LOCKWASHER, SPLIT 5/16 SS	4
25	XB-L795245-0A	SPACER RING	1
26		INTENTIONALLY LEFT BLANK	
27		INTENTIONALLY LEFT BLANK	
28	XB-991107-06	HEX HEAD CAP SCREW 3/8-24 X 3/4	8
29	XB-991606	WASHER, FLAT 3/8 SS	8
30	XB-L832823-01	SNAP RING	1
31	XB-779445-0A	LINK BOARD ASSEMBLY	1
32	XB-997873	BAFFLE ALTERNATOR AIR EXHUAUST - OPTIONAL *	1

\* NOT SHOWN



**SUPPLEMENTAL  
ALTERNATOR  
MANUAL**

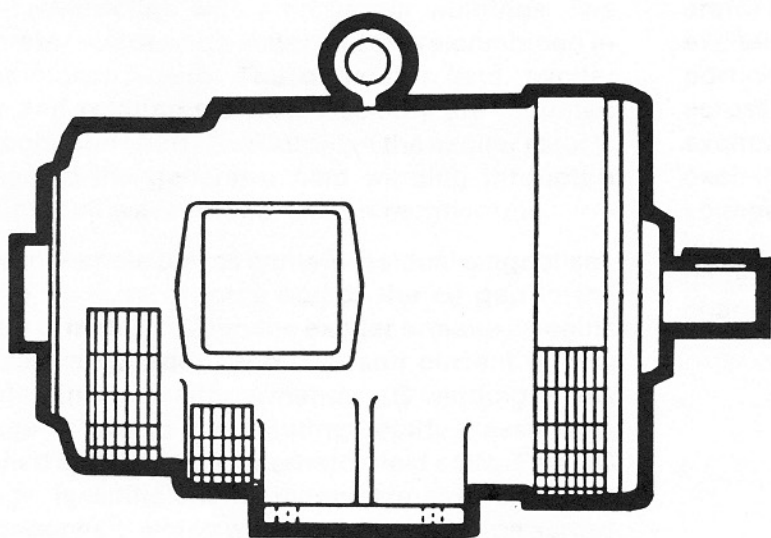






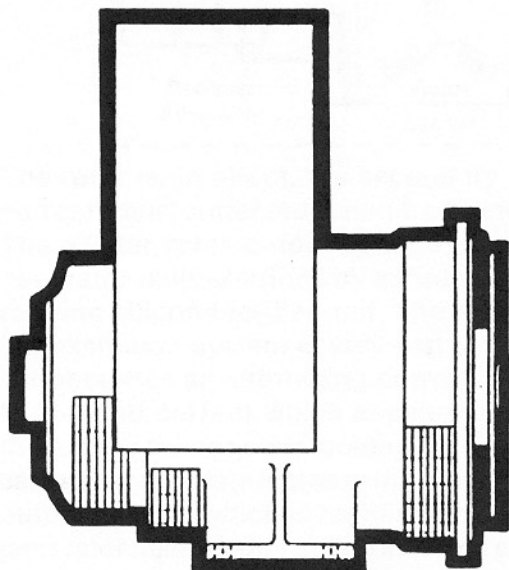
## INSTALLATION, OPERATION AND MAINTANENCE MANUAL

### **TYPE MAC Brushless AC Synchronous, Internally Regulated Alternator Frame 280**



**Marathon Electric Mfg., Corp.**  
100 East Randolph Street  
P.O. Box 8003  
Wausau, WI 54402-8003  
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**Making Energy Work For You**



## TABLE OF CONTENTS

	Page No.
Principle of Operation .....	3
Circuit Diagram .....	3
Performance Data .....	4
<b>SECTION I</b>	
Installation .....	4
Wiring Connections .....	4
Operation .....	4
Standby & Parallel Operation .....	4
Overload .....	4
Lubrication .....	4

## SECTION II

Bearing Replacement .....	5
Rotor Damage Repair Procedures .....	5
Generator Windings (Drying) .....	5, 6
Restoring Residual Magnetism .....	6
Rectifier Assembly Drawing .....	6
Testing Diodes .....	6
Rotating Rectifier Removal Procedure .....	6, 7
Troubleshooting Procedures	
AC Brushless Generators .....	7, 8

## SECTION III

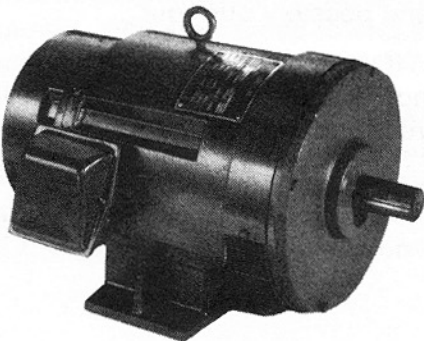
Connection Diagrams .....	9, 10
Parts List .....	11

### PRINCIPLE OF OPERATION

The MAC generator is a self-regulated, rotating field synchronous unit with the rotor having a salient pole construction with amortisseur windings. The generator stator and exciter stator are combined in a common housing. The generator field, exciter rotor and rotating rectifier assembly are mounted on a common shaft. The output of the exciter rotor is applied to the generator field winding through a rotating, full wave bridge, silicon rectifier unit.

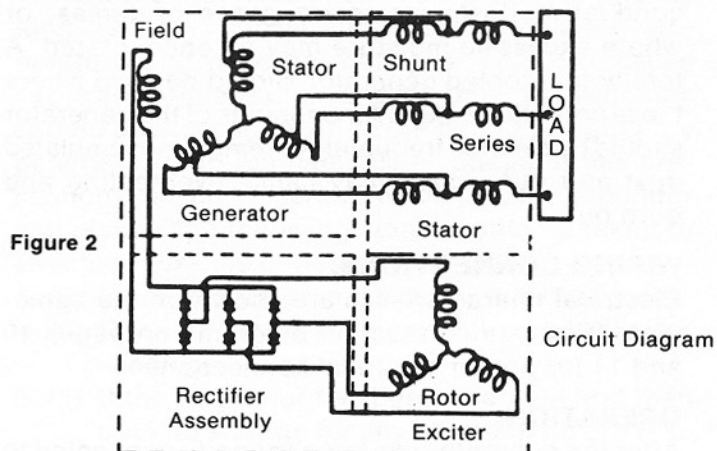
The exciter pole pieces contain residual magnetism, setting up lines of force across the air gap to the exciter armature. When the exciter armature begins to rotate a voltage is induced and current flow is initiated in the exciter armature AC windings. This voltage is fed to the rotating rectifier assembly, rectified and fed to the alternator field coils. This DC voltage is sufficient to magnetize the laminated alternator field which will set up lines of force across the air gap to the alternator stator. As the generator rotor rotates a voltage will be induced and current will flow in the alternator stator windings and to the output circuit.

All connections between the exciter stator windings and the generator stator windings are internally connected within the stator housing. Only the output power leads of the generator unit are brought out to the generator terminal box.



### CIRCUIT DIAGRAM

Figure 2 shows the internal schematic diagram of the generator, exciter and rectifier unit. The generator is a three phase unit and the exciter stator and exciter rotor also have three phase windings. A portion of the exciter stator windings is connected across a tap on the generator stator winding. This exciter shunt winding provides the generator field excitation power required for the generator no load voltage. Another portion of the exciter stator windings is connected in series with the output of the generator and provides a compounding excitation characteristic.



The rotor is, in effect, the secondary of a rotating current transformer induction frequency converter. The exciter rotor output voltage is applied to the generator field windings by a three phase full wave rotating silicon rectifier unit. The response time of the excitation system is very fast since the exciter stator carries an alternating current corresponding to the load current which appears immediately on the exciter primary. An increase in load current will cause an immediate increase in the exciter secondary output voltage which is rectified and applied to the generator field windings. The inherent compounding characteristics of the excitation system provide excellent voltage regulation even under heavy overload conditions.

PERFORMANCE DATA

The excitation characteristics of fast exciter response with maximum exciter output makes this generator ideal for motor starting loads that require a very high current at low power factor during the motor starting and acceleration periods. At the same time it offers the rugged, reliable, maintenance-free operation inherent in the brushless type generator. No external controls are needed with a Lima MAC generator.

The performance of a 10 kW Lima MAC synchronous generator is indicated in Figure 3.

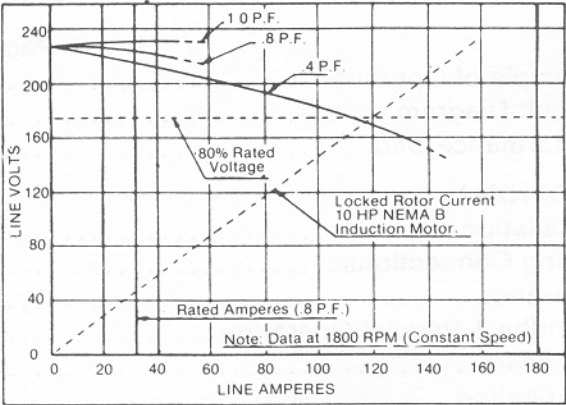


Figure 3

SECTION I  
INSTALLATION AND OPERATION

UNPACKING:

When unpacking, check for damage in shipping. Report any damage at once to delivering carrier. Read instruction tags shipped with generator.

INSTALLATION:

The generator must be properly aligned and located in a well-ventilated place where the air temperature will not exceed 40°C or 104°F, and should be accessible for cleaning. An open type generator should not be located where there are abrasive or conductive dusts, corrosive gases or fumes, or where excessive moisture may be encountered. A totally fan-cooled generator should be used where these conditions exist. Air openings of the generator should be cleaned frequently to remove accumulated dust and dirt, which may cause overheating and burn out.

WIRING CONNECTIONS:

Electrical characteristics are shown on the nameplate. Refer to connection diagrams on pages 10 and 11 for proper electrical connections.

OPERATION:

After the generator has been properly connected to the driving unit and the load lines connected to the generator's leads according to the wiring diagram, the unit is ready for operation. To connect the coupling discs of a single bearing generator to the driving engine's flywheel it may be necessary to slide the rotor forward a few inches out of the stator, taking care not to slide it so far as to cause the rotor to come out of the bearing entirely and down upon the stator windings, causing damage to the windings.

Ordinarily, a chain hoist is needed to jockey the generator rotor into position.

STANDBY UNITS:

Generators used as an auxiliary power source in case of commercial power failure must be isolated from the commercial line before being placed in operation.

**CAUTION:** MAKE SURE UNIT IS COMPLETELY SHUT DOWN AND FREE OF ANY POWER SOURCE BEFORE ATTEMPTING ANY REPAIR OR MAINTENANCE ON THE UNIT.

PARALLEL OPERATION:

For parallel operation, both units must be of the same voltage, frequency, and phase. Phase voltages of paralleled units must be synchronized. This generator set utilizes the "dark lamp" method of paralleling.

ROTATION:

The generator can be operated in either direction of rotation.

OVERLOAD:

The load on the generator should be checked with an AC ammeter to see that the ampere rating stamped on the nameplate is not exceeded. Prolonged overload on the generator may cause it to overheat and possibly burn out.

LUBRICATION:

Ball bearings on Lima generators are pre-lubricated and require no further lubrication for the life of the bearing.



## SECTION II

### SERVICE AND MAINTENANCE

#### PREVENTATIVE MAINTENANCE AND OPERATING PERCAUTIONS:

Costly repairs and down time can usually be prevented by operating electrical equipment under conditions which are compatible with those at which the equipment was designed to operate. Follow the instructions as outlined to insure maximum efficient utilization of the electrical equipment.

#### COOLING:

Keep all cooling parts clean and make certain sufficient room is left on all sides for a plentiful supply of fresh coolant air flow. **DO NOT EXCEED AIR TEMPERATURE RISE AS SHOWN FOR 50°C ABOVE A 40°C AMBIENT.** This insures that the insulation NEMA Class "F" will not be damaged. **DO NOT EXCEED RATED LOAD**, except as specified for the equipment. **OPERATE AT RATED SPEED.** Failure to operate generators at rated load or speed will cause overheating and possibly damage to windings due to over voltage or current.

#### BEARING REPLACEMENT:

Factor lubricated shielded bearings will normally provide several years of trouble free service when operated under normal conditions. Excessive bearing load and adverse environment conditions will greatly shorten bearing life. Should bearing failure occur, bearings can be replaced. **ALWAYS REPLACE WITH THE SAME TYPE BEARING AS INSTALLED AT THE FACTORY. CHECK PARTS LIST FOR PART NUMBER.** Include generator serial number when ordering bearings.

#### ROTATING DIODE BRIDGE:

The rotating diode bridge can be removed and replaced. Excessive overcurrent, overvoltage, overspeed, or reverse currents can cause damage to the assembly or any of the component parts.

#### ROTOR DAMAGE:

The damper bars of the generator prevent excessive hunting when AC generators are operated in parallel. Damper bars, because they must have a low electrical resistance and are subjected to extreme centrifugal forces, must be mechanically secure and permanent. Consequently, they are welded to end plates completely covering the field.

All rotors are static and dynamically balanced to a high degree on precision machines to assure minimum vibration. They will, therefore, remain dynamically stable at speed well beyond the synchronous speed of the generator. The rotors on generators

are, however, subjected to extreme centrifugal forces which can increase beyond safe operating limits at excessive overspeed. Therefore, the prime mover should be adequately governed to prevent overspeed.

Damage to the rotor can also occur due to overheating which can be caused by the air flow being restricted from dust or other foreign objects collecting in the air passage.

If a rotor becomes defective, it should be returned to the factory with full nameplate data, because the rotor coils are enclosed in welded squirrel cage winding. To repair a rotor the special tooling and technique of the factory is necessary and essential. The Lima Electric Company, Incorporated, facilities can perform a complete rebuild, or rewind job with greater skill and craftsmanship than can be found in the average motor rewind shop. Should a failure occur, the factory should be notified immediately and steps will be taken to get the generator back into service with the least expense; and more important, to determine the cause of the failure and take steps to prevent a recurrence.

#### PRECAUTIONS:

##### GENERATOR WINDINGS (DRYING):

Generators that have been in transit or storage for long periods may be subjected to extreme temperature and moisture changes. This can cause excessive condensation, and the generator windings should be thoroughly dried out before bringing the generator up to full nameplate voltage. If this precaution is not taken, serious damage to the generator can result. The following steps should be taken to effectively dry the generator windings:

- A. (1) Place generator in drying oven or hot room.
- (2) Dry with warm air blower directed through windings.
- B. (1) If the generator has been operated and then put into storage for any period of time, a P.D. George #11127 type air-dry fungus resistant varnish should be reapplied.

Experience has shown that it is necessary to take these precautions in locations such as seaboard installations and other highly humid areas. Some installations will be in atmospheres that are much more corrosive than others. A little precaution along the lines outlined here could eliminate an unnecessary repair job.

Each generator was subjected to a standard NEMA insulation test, which means 1000 volts plus twice the highest voltage for which the generator is rated was impressed between the winding and frame. All machines are insulated with a high safety factor for the class of insulation used. The latest and newest in insulation and baking techniques are used.

The finest insulation job can be very quickly broken down carelessly applying high voltage to windings in a moisture saturated condition. Mishandling in this respect can easily cause a breakdown, making it necessary to return the generator to the factory for repair, and consequent expense and loss of time.

**WARNING: HIGH VOLTAGE (DIELECTRIC) TESTING MUST NOT BE PERFORMED TO THE MACHINE WITHOUT FIRST OBSERVING NEMA RULES. THE INSULATION OF THIS GENERATOR WINDING MAY BE SAFELY CHECKED BY USING A MEGGER. A HIGH MEGGER READING INDICATES LOW INSULATION LEAKAGE.**

#### RESTORING RESIDUAL MAGNETISM:

The current necessary to magnetize the alternator field is obtained from the exciter. Initially, upon starting the generator, current flow and voltage are induced into the exciter armature by the magnetic lines of force set up by the residual magnetism of the exciter field poles.

Residual magnetism of the exciter field poles may be lost or weakened by a strong neutralizing magnetic field from any source, or if the generator is not operated for a long period of time.

Should the generator fail to build up voltage after being disassembled for any reason, a momentary short-circuit of any two generator leads should be

sufficient to correct this condition. If not, an alternate method may be used. Apply either an alternating current or a direct current voltage of approximately 20 volts to any to generator leads. Do not make a positive connection but rather touch the leads together until the generator voltage begins to rise and then remove. It is suggested that a 30 ampere fuse be inserted in the circuit to prevent any damage in case the build-up voltage is not removed quickly enough.

Start generator and observe generator build-up. Re-flash field if generator output voltage does not build up.

#### TESTING DIODES WITH AN OHMMETER:

Isolate the rectifier assembly by disconnecting the two leads from the main rotor and three leads from the exciter rotor. Do not unsolder diodes. Test each diode by applying the probes of an ohmmeter to the anode and cathode.

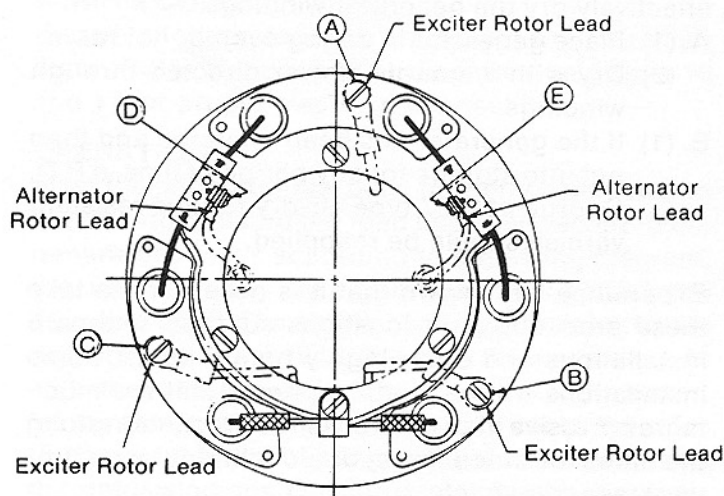
A good diode will produce a meter reading of only a few ohms when the probes are applied in one direction, and a reading of near infinity when the probes are reversed. If both readings are high, or both are low, the diode is defective and must be replaced.

Diode failure after a 25 hour "run-in" period is generally traceable to external causes such as lightning strike, overheating or a reverse current fed into the alternator. To save excessive service time and call-backs, it is a generally accepted practice to replace the entire rectifier assembly where failure can be traced to external causes AFTER THE CAUSE OF DIODE FAILURE IS IDENTIFIED AND CORRECTED.

#### RECTIFIER REMOVAL PROCEDURE:

Rectifiers may be removed through the bearing cap on the rear of the generator. (See Figure 6, Item B.) First, remove the bearing cap by removing the four bolts shown in Figure 6 as Item A. You can now see both the bearing (Item C) and rectifier assembly (Item D). Use a bearing puller to remove the bearing from the main shaft being careful to locate the puller on the inner race of the bearing to avoid bearing damage. Once the bearing is free it is then necessary to disconnect leads A, B, C and D as shown in Figure 5 assembly drawing. Then remove the three hold-down cap screws which secure the rectifier assembly to its adaptor. Once this procedure is complete the rectifier assembly is free for removal.

Follow the testing procedures outlined in testing diodes and Figure 5.



Rectifier Assembly 778600  
Figure 5



After the rectifier assembly has been repaired or replaced, reverse the procedure as stated above, being careful that all lead connections are tight and that set screws are locked with a Lock-Tite compound.

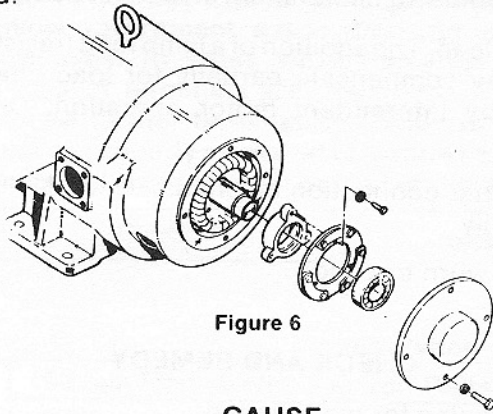


Figure 6

## TROUBLESHOOTING PROCEDURES

### AC BRUSHLESS GENERATOR

As with any machine, trouble may develop in electrical generators. It may be due to long service or neglect of regular maintenance, servicing, and checking. Should trouble develop, the following instructions will be helpful in tracing the cause and making repairs.

#### SPEED DEVIATIONS:

The generator speed should be maintained at rated nameplate speed. The frequency and voltage of the generator output depends on speed. If the generator runs slower than rated speed, the voltage will drop off.

#### NO VOLTAGE:

##### CAUSE

- Loss of residual magnetism in exciter field poles.
- Open in stator windings.
- \* Open or short in rotating rectifiers.
- Short circuited.
- \* Open in alternator field.
- \* Shorted exciter armature.
- \* Shorted leads between exciter armature and generator field.

**NOTE:** \*Designate rotating parts. Generator must be open to test.

##### CHECK AND REMEDY

- Flash field, see page 6 "Restoring Residual Magnetism."
- Check for continuity in windings. Return to factory for repair if open.
- Check rectifiers per previous instructions, replace if faulty.
- Clear lead to restore voltage build-up.
- Check for continuity and return rotor to factory for repair if field coils are open.
- Check for short and replace if faulty. Use a "Kelvin" type bridge to measure this resistance.
- Test and repair.

#### LOW VOLTAGE:

##### CAUSE

- Excessive load.
- Low speed.
- Line loss.
- High resistance connections — connection will be warm or hot.
- Shorted field.
- Low power factor.

##### CHECK AND REMEDY

- Reduce load. With 3 phase generators, the load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
- Check engine for malfunction or system for overload.
- Increase size of line lead wire.
- Make better connection electrically and mechanically.
- Test field coils for possible short by checking resistance with an ohmmeter or resistance bridge. Return rotor assembly to factory for repair if alternator field coils are shorted.
- Reduce inductive (motor) load. Some AC motors draw approximately the same current regardless of load. Do not use motors of larger horsepower rating than is necessary to carry the mechanical load.

### FLUCTUATING VOLTAGE:

(May be indicated by flickering lights)

CAUSE	CHECK AND REMEDY
Irregular speed of engine.	Check engine for malfunction or load for fluctuation.
Fluctuating speed.	Stabilize load. The addition of a lamp load (resistance load) may compensate partially for load changes caused by intermittent motor operation. Do not overload.
Loose terminal or load connections.	Make better connection mechanically and electrically.
Defective bearing causing uneven air gap.	Replace worn bearing.

### HIGH VOLTAGE:

CAUSE	CHECK AND REMEDY
Excessive speed.	Check engine for malfunction.

### OVERHEATING:

CAUSE	CHECK AND REMEDY
Generator overloaded.	Reduce load. (Check with ammeter and compare with nameplate rating.)
Clogging ventilating screens.	Clean air passages.
High room temperature	Improve ventilation.
Insufficient circulation.	Provide cross-ventilation.
Low power factor.	Reduce inductive loads or install power factor improvement capacitors.
Unbalanced load.	The load on each leg should be as evenly balanced as possible and should not exceed the rated current on any leg.
Dry bearing.	Replace bearing.

### MECHANICAL NOISE:

CAUSE	CHECK AND REMEDY
Defective bearing.	Replace bearing.
Rotor scrubbing on stator.	Bad bearing, replace. Bent shaft, return to factory. Loose endbell, tighten; loose drive discs, tighten.
Loose laminations.	Return to factor for repair.
Loose or misaligned coupling.	Tighten or align.

### GENERATOR FRAME PRODUCES SHOCK WHEN TOUCHED:

CAUSE	CHECK AND REMEDY
Static charge.	Ground generator frame.
Grounded armature or field coil.	Return to factory for repair.

## ELECTRICAL WIRING PROCEDURES — WIRING DIAGRAMS

## CAUTION

Wiring of the alternator should be done in accordance with good electrical practices. Follow government, association and industry standards. In some wiring arrangements, groups of terminals are connected together with no further termination. These terminals must be properly insulated to avoid a hazard to personnel and potential equipment damage.

Lima MAC alternators are supplied in 10-lead or 12-lead configurations. From the nameplate information and system voltage requirements, select the appropriate wiring diagram from the information that follows.

## WIRING REFERENCE CHART

Configuration		MAC Type Specific Voltage (60 HZ)	Ref. Diag.
3 Phase	12-Lead Unit, 4-Wire 240 Volt Delta Connected	240V	A
	12-Lead Unit, High Voltage Wye Connected	416V	B
	12-Lead Unit, Low Voltage Wye Connected	208V	C
	10-Lead Unit, High Voltage Wye Connected	480V	D
	10-Lead Unit, Low Voltage Wye Connected	240V	E
1 Phase	12-Lead Unit, Low Voltage Delta	120V	F
	12-Lead Unit, 240 Volt Zigzag	240V	G

DIAGRAM A

## 12-Lead Unit, 240 Volt, Delta Connected, 3 Phase

Connect together the following six sets of terminations:

T1 and T12 to form L1    T2 and T10 to form L2  
T3 and T11 to form L3    T4 and T7 to form L0  
T5 and T8

**OUTPUTS:** 120V, 1Ø    240V, 3Ø  
L1 to L0    L1 to L2  
L2 to L0    L2 to L3  
L1 to L3

**CAUTION:** Properly insulate all unused terminations.

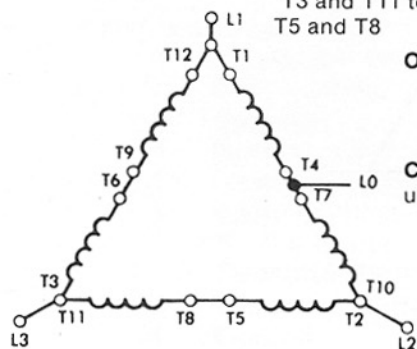


DIAGRAM B

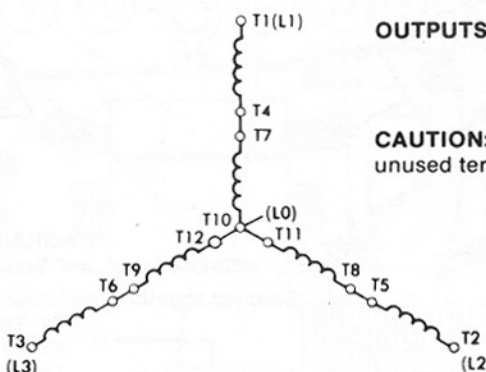
## 12-Lead Unit, High Voltage, Wye Connected, 3 Phase

Connect together the following four sets of terminations:

T4 and T7    T5 and T8    T6 and T9  
T10, T11 and T12 to form L0  
T1 is L1    T2 is L2    T3 is L3

**OUTPUTS:** 240V, 1Ø    416V, 3Ø  
L1 to L0    L1 to L2  
L2 to L0    L2 to L3  
L3 to L0    L1 to L3

**CAUTION:** Properly insulate all unused terminations.





**DIAGRAM C**

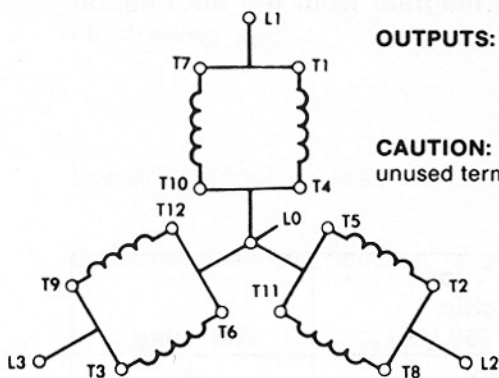
**12-Lead Unit, Low Voltage, Wye Connected, 3 Phase**

Connect together the following four sets of terminations:

T1 and T7 to form L1      T2 and T8 to form L2  
T3 and T9 to form L3  
T4, T5, T6, T10, T11 and T12 to form L0

**OUTPUTS:** 120V, 1Ø      208V, 3Ø  
L1 to L0      L1 to L2  
L2 to L0      L2 to L3  
L3 to L0      L1 to L3

**CAUTION:** Properly insulate all unused terminations.



**DIAGRAM D**

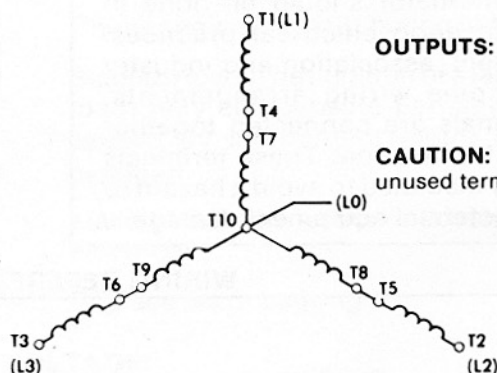
**10-Lead Unit, High Voltage, Wye Connected, 3 Phase**

Connect together the following four sets of terminations:

T4 and T7      T5 and T8      T6 and T9  
T1 is L1      T2 is L2      T3 is L3

**OUTPUTS:** 277V, 1Ø      480V, 3Ø  
L1 to L0      L1 to L2  
L2 to L0      L2 to L3  
L3 to L0      L1 to L3

**CAUTION:** Properly insulate all unused terminations.



**DIAGRAM E**

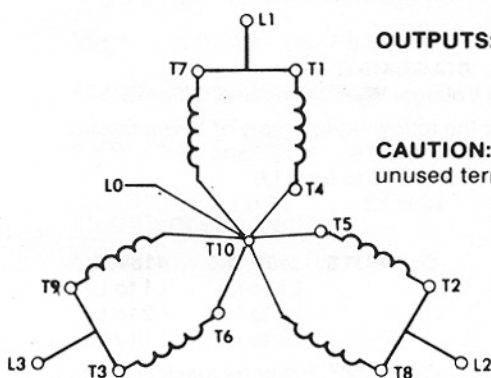
**10-Lead Unit, Low Voltage, Wye Connected, 3 Phase**

Connect together the following four sets of terminations:

T1 and T7 to form L1      T2 and T8 to form L2  
T3 and T9 to form L3  
T4, T5, T6 and T10 to form L0

**OUTPUTS:** 139V, 1Ø      240V, 3Ø  
L1 to L0      L1 to L2  
L2 to L0      L2 to L3  
L3 to L0      L1 to L3

**CAUTION:** Properly insulate all unused terminations.



**DIAGRAM F**

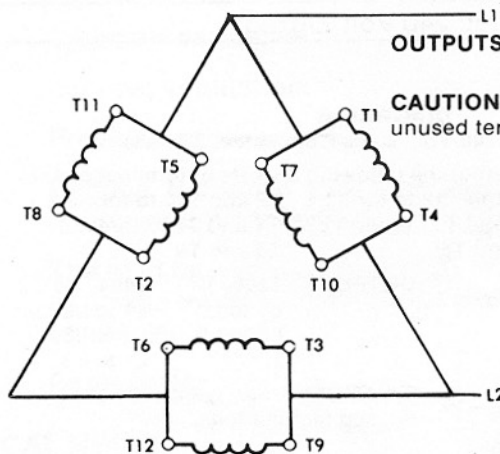
**12-Lead Unit, Low Voltage, Delta Connected, 1 Phase**

Connect together the following three sets of terminations:

T2, T8, T6, T12 and Insulate  
T1, T5, T7, T11 to form L1  
T3, T4, T9, T10 to form L2

**OUTPUTS:** 120V, 1Ø  
L1 to L2

**CAUTION:** Properly insulate all unused terminations.



**DIAGRAM G**

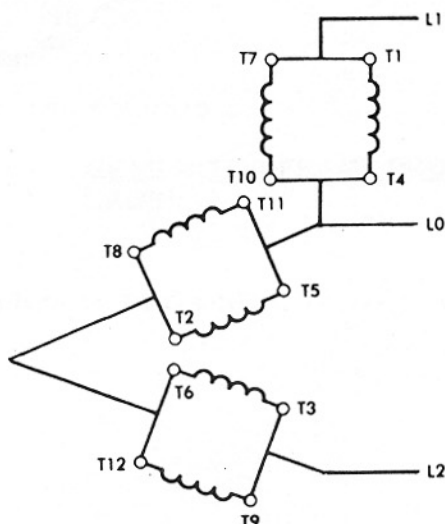
**12-Lead Unit, 240 Volt, Zigzag, 1 Phase**

Connect together the following four sets of terminations:

T2, T8, T6, T12 and Insulate  
T1, T7, to form L1  
T3, T9, to form L2  
T4, T10, T5, T11 to form L0

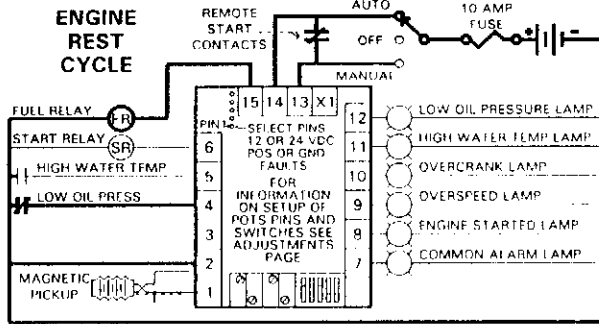
**OUTPUTS:** 120V, 1Ø      240V, 1Ø  
L1 to L0      L1 to L2  
L2 to L0

**CAUTION:** Properly insulate all unused terminations.

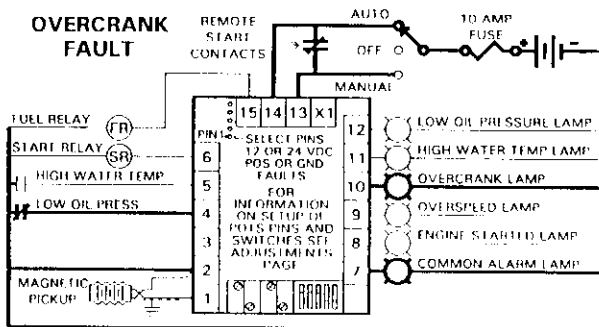


## SPECIFICATIONS

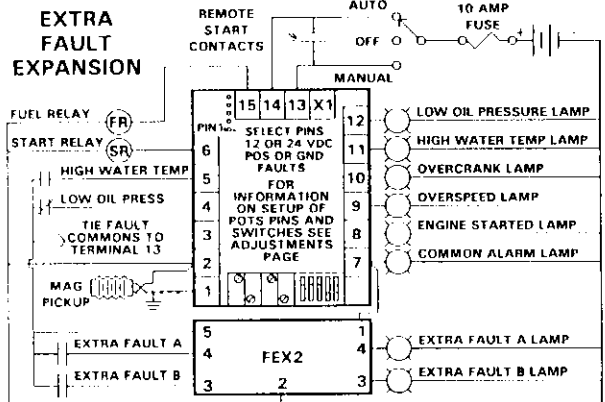
Temperature Range	-40 TO +85 C
Voltage Range (12V)	9 to 15 VDC
Voltage Range (24V)	19 to 28 VDC
Vibration	10 G's
Standby Current	0 Amps
Operating Current	200 mA
Maximum life cycles	50,000
Starter and Fuel Output	5 Amps
Signal outputs (total)	1 Amp
Speed input range	2 to 15 VRMS
Input Impedance	5 kohms
Weight	17.5 oz.
Crank Cycle Time Single	2 to 67 sec
Crank Cycle Time Multi	2 sec to 16 min
Crank attempts	1 to 8
Low oil pressure delay	2 to 60 sec
Crank disconnect trip	250 Hz to 8500 Hz
Overspeed trip	250 Hz to 8500 Hz
Verify mode	87% of set point



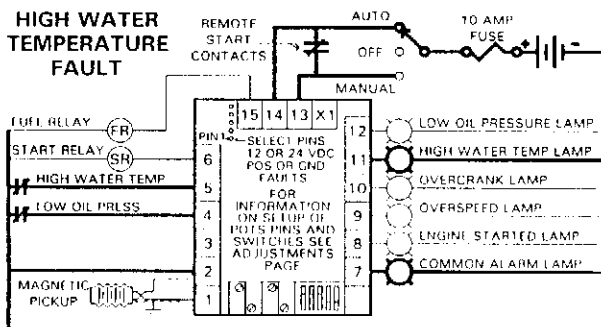
The REST cycle is a pause in the cranking sequence and only applies if Dip Switch 4 on the module is in the Off position. In this mode Fuel is still applied to the engine but the Starter Relay signal is turned off. The cycle continues for the duration of the Cycle time Adjustment Setting. The Low Oil Pressure fault signal input is ignored. To set cycle Time and Crank Attempts see adjustments page.



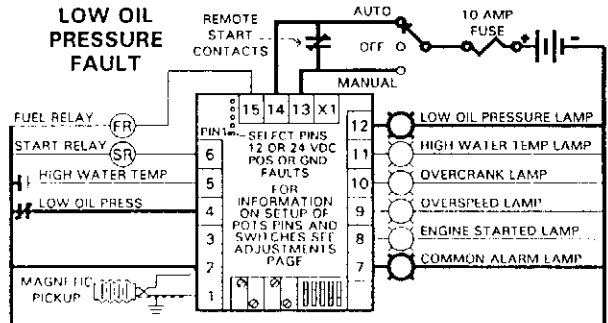
If the engine does not start in the allotted time, as determined by the Crank Cycle Adjust and the Dip Switch settings, the Overcrank Fault occurs. The Fuel and Start relays are turned off and the appropriate signals indicate as shown. The LED version indicates via LED also. The Overcrank condition is a latched condition and must be reset via the Engine Control Switch. See Adjustments page for proper settings of adjustments.



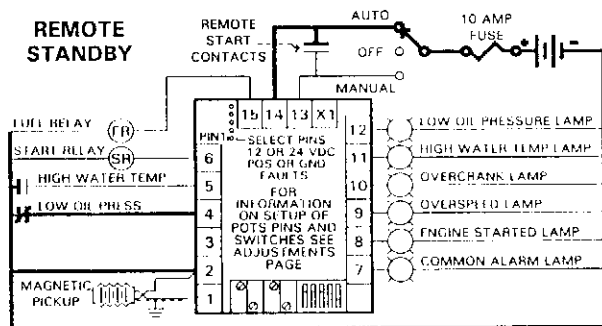
The FEX2 is shown expanding the control to 6 total engine faults. The FEX2 provides both the fault combining signal circuits and the latch circuits. Placing voltage on terminal 7 will place unit in shutdown but it will not latch. See FEX2 literature for more information.



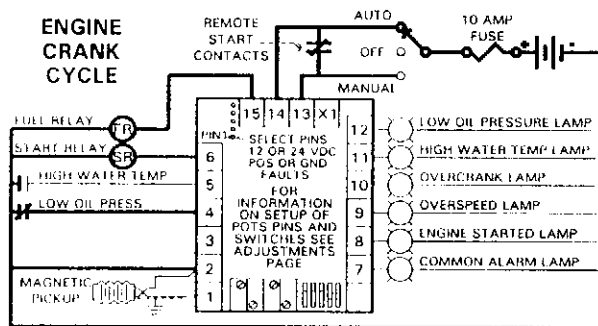
If the High Water Temperature Switch closes the engine will be shut down immediately. System indicates as shown and the LED version indicates via LED also. The Engine Switch must be placed in OFF and the engine allowed to cool for reset. The above circuit is grounded fault if you are using positive fault tie your fault switch common to terminal 13. See Adjustments page for fault polarity and delay time adjustments.



Upon crank termination the Low Oil Pressure time delay begins. After this delay period if the Low Oil Pressure switch closes the engine will shutdown immediately. The Fuel Relay is turned off and the appropriate signals indicate as shown. The LED version indicates via LED also. The Engine Switch must be placed in OFF for reset. The above circuit is grounded fault if you are using positive fault tie your fault switch common to terminal 13. See Adjustments page for fault polarity and delay time adjustments.



In the Standby mode the Engine Control Switch is in the Auto position as the module monitors the Remote Start Contacts. All that is required for cranking to begin is the closure of the Remote Start Contacts shown connected across terminals 13 and 14.



Closure of the Remote Start Contacts while in AUTO initiates the Crank mode. The Fuel Relay and Starter Relay are energized causing the engine to begin cranking. The Crank mode will continue for the duration of the settings of the Crank Cycle Adjust and the Dip Switch, unless Overcrank occurs first. During the Engine Crank Cycle the Low Oil Pressure Switch is ignored. To set Cycle Time and Crank Attempts see adjustments page.

### ADJUSTMENTS PAGE

**12 VOLT GROUNDED FAULT**  
(PIN 1)

**12 VOLT POSITIVE FAULT**  
(PIN 1)

**24 VOLT GROUNDED FAULT**  
(PIN 3)

**24 VOLT POSITIVE FAULT**  
(PIN 3)

ALL INSTRUCTION PAGES IN THIS MANUAL INDICATE CLEARLY THE ORIENTATION OF PIN 1

**WARNING - NEVER SHORT PIN 1 TO PIN 3 A SHORT CIRCUIT WILL OCCUR AND BLOW OUT UNIT**

**FUSE DATA - ECU T031**  
**LITTLE FUSE 273001 1AMP**

**POT ADJUSTMENTS**

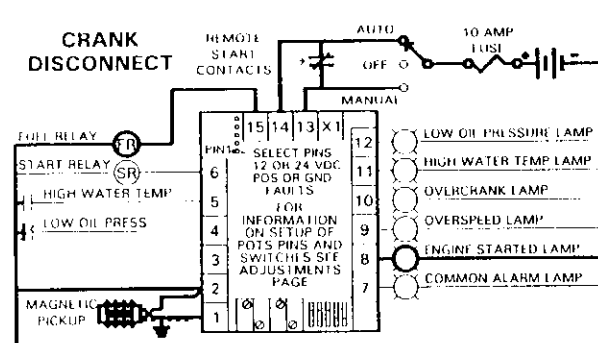
POTS ARE 25 TURN AND CAN NOT BE DAMAGED BY EXCESS TURNS

TURN POTS CLOCKWISE TO INCREASE SETTING

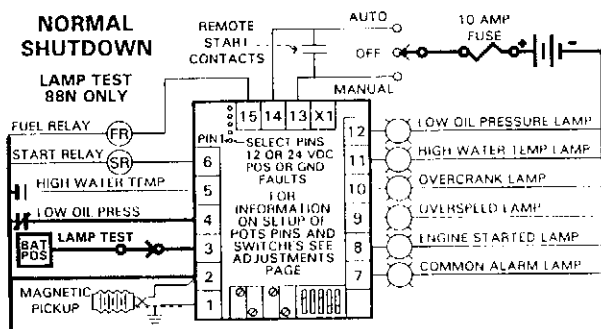
### VOLTAGE AND FAULT POLARITY MODE SELECT PINS

**SW5 ON REDUCES TRIP SPEEDS BY FIFTEEN PERCENT**

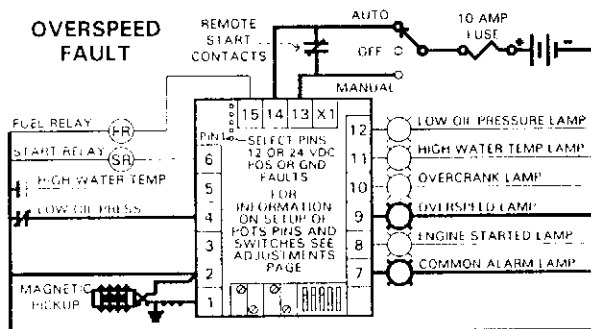
SW1	SW2	SW3	CYCLES
OFF	OFF	OFF	1
OFF	ON	OFF	2
ON	OFF	OFF	3
ON	ON	OFF	4
OFF	ON	ON	5
ON	ON	ON	6
ON	OFF	ON	7
ON	ON	ON	8



If the internal speed switch detects a speed equal or above the Crank Disconnect Adjustment Setting the starter relay signal turns off, the Low Oil Pressure delay timer is initiated and the appropriate signals indicate as shown. The LED version indicates via LED also. This is a latched condition and must be reset by placing the Engine Control Switch in the Off position. The internal speed switch uses the Magnetic Pickup for speed detection.



To stop engine place switch in the OFF position and engine will shut down immediately. The Fuel Relay is turned off and the unit draws no power. If the unit is a LED version lamp test may be applied as shown and all LEDs will light. Since the output system is totally independent of the signal system Lamp Test can be actuated at any time with no possibility of backfeed.



The Overspeed fault is armed at engine cranking. If the internal speed switch detects a speed equal or above the Overspeed Adjustment Setting the engine is shutdown immediately. The internal speed switch uses the Magnetic Pickup for speed detection. The Fuel Relay is turned off, the Low Oil Pressure switch is locked out and the appropriate signals indicate as shown. The LED version indicates via LED also. The Engine Switch must be placed in OFF for reset. See Adjustments page for fault polarity and delay time adjustments.

